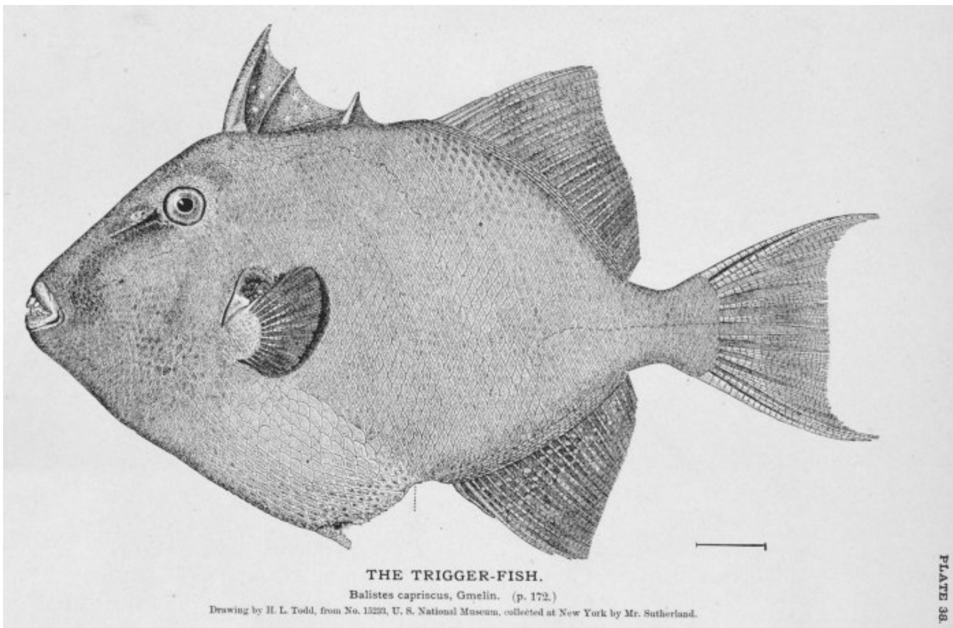
Southeast Data, Assessment, and Review

SEDAR 9

Gulf of Mexico Gray Triggerfish

Balistes capriscus



SECTION II. Data Workshop Report

Developed by the Data Workshop Panel

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SEDAR

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1 Introduction

1.1 Workshop Time and Place

The SEDAR 9 Data Workshop convened 20-24 June 2005, at the Hotel Moteleone, New Orleans, Louisiana.

1.2 Terms of Reference

1. Characterize stock structure and develop a unit stock definition.

2. Tabulate available life history information (e.g., age, growth, natural mortality, reproductive characteristics). Provide models to describe growth, maturation, and fecundity by age, sex, or length as appropriate; recommend life history parameters (or ranges of parameters) for use in population modeling; evaluate the adequacy of life-history information for conducting stock assessments.

3. Provide indices of population abundance. Consider fishery dependent and independent data sources; develop index values for appropriate strata (e.g., age, size, area, and fishery); provide measures of precision; conduct analyses evaluating the degree to which available indices adequately represent fishery and population conditions. Document all programs used to develop indices, addressing program objectives, methods, coverage, sampling intensity, and other relevant characteristics.

4. Characterize commercial and recreational catches, including both landings and discard removals, in weight and numbers. Evaluate the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector. Provide length and age distributions if feasible.

5. Evaluate the adequacy of available data for estimating the impacts of current management actions.

6. Recommend assessment methods and models that are appropriate given the quality and scope of the data sets reviewed and management requirements.

7. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity and coverage where possible.

8. Prepare complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report).

1.3 List of Participants

Workshop Panel Members:

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1.4 List of Data Workshop Working Papers

Document #	Title	Authors
Documents Prepared for the SEDR 9 Data Workshop		
SEDAR9-DW1	History of vermillion snapper, greater amberjack, and gray triggerfish management in Federal waters of the US Gulf of Mexico, 1984-2005	Hood, P
SEDAR9-DW11	Length Frequency Analysis and Calculated Catch at Age Estimations for Commercially Landed Gray Triggerfish (*Balistes capriscus*) From the Gulf of Mexico	Steven Saul
SEDAR9-DW12	Estimated Gray Triggerfish (*Balistes capriscus*) Landings From the Gulf of Mexico Headboat Fishery	Steven Saul
SEDAR9-DW13	Estimated Gray Triggerfish (*Balistes capriscus*) Commercial Landings and Price Information for the Gulf of Mexico Fishery	Steven Saul
SEDAR9-DW14	Estimated Gray Triggerfish (*Balistes capriscus*) Recreational Landings for the State of Texas	Steven Saul
SEDAR9-DW15	Estimated Gray Triggerfish (*Balistes capriscus*) Landings From the Marine Recreational Fishery Statistics Survey (MRFSS) In the Gulf of Mexico	Steven Saul and Patty Phares
SEDAR9-DW16	Length Frequency Analysis for the Gray Triggerfish (*Balistes capriscus*) Recreational Fishery In the Gulf of Mexico	Steven Saul
SEDAR9-DW17	Estimates of Vermilion Snapper, Greater Amberjack, and Gray Triggerfish Discards by Vessels with Federal Permits in the Gulf of Mexico	Kevin J. McCarthy
SEDAR9-DW18	Size Composition Data from the SEAMAP Trawl Surveys	Scott Nichols
SEDAR9-DW21	SEAMAP Reef Fish Survey of Offshore Banks: Yearly indices of Abundance for Vermilion Snapper, Greater Amberjack, and Gray Triggerfish	Gledhill, et. al.
SEDAR9-DW22	Data Summary of Gray Triggerfish (*Balistes capriscus),* Vermilion Snapper (*Rhomboplites aurorubens)*, and Greater Amberjack (*Seriola dumerili)* Collected During Small Pelagic Trawl Surveys, 1988 – 1996	G. Walter Ingram, Jr.
SEDAR9-DW23	Abundance Indices of Gray Triggerfish and Vermilion Snapper Collected in Summer and Fall SEAMAP Groundfish Surveys (1987 – 2004)	G. Walter Ingram, Jr.
SEDAR9-DW25	Review of the early life history of gray triggerfish, *Balistes capriscus,* with a summary of data from SEAMAP plankton surveys in the Gulf of Mexico: 1982, 1984 – 2002	Lyczkowski-Shultz, J., Hanisko, D. and Zapfe, G.

SEDAR9-DW26	Shrimp Fleet Bycatch Estimates for the SEDAR9 Species	Scott Nichols
SEDAR9-DW27	SEAMAP Trawl Indices for the SEDAR9 Species	Scott Nichols
SEDAR9-DW-28	Standardized Abundance Indices for Gulf of Mexico Gray Triggerfish (*Balistes capriscus)* based on catch rates as measured by the Marine Recreational Fisheries Statistics Survey (MRFSS)	Josh Sladek Nowlis
SEDAR9-DW-29	Standardized Abundance Indices for Gulf of Mexico Gray Triggerfish (*Balistes capriscus)* based on catch rates as measured by the NMFS Southeast Zone Headboat Survey	Josh Sladek Nowlis
SEDAR9-DW-30	Standardized Abundance Indices for Gulf of Mexico Gray Triggerfish (*Balistes capriscus)* based on catch rates as measured from commercial logbook entries with handline gear	Josh Sladek Nowlis

2 Life History

2.1 Age and Growth

2.1.1 Annulus Formation

Patterns in recreationally-caught, Alabama gray trigger growth, catch-per-unit-effort (CPUE), reproduction, and increment formation in first dorsal spines, as well as the relatedness of these patterns, is summarized by Ingram (2001) in order to validate the use of the first dorsal spine as an age estimator (Fig. 1). Both the relative marginal increment analysis, and the monthly condition of the margin of the first dorsal spines indicate that a translucent annual ring forms in December-February, and that a spawning check forms in some fish during July-August. Both of these time periods represent periods of slow somatic growth and low CPUE. The spring increase in CPUE corresponds with spring growth as indicated in the first dorsal spine by the formation an opaque band. Ingram (2001) reasoned that changes in CPUE directly correspond to changes in feeding activity and not to changes in abundance, and provide a rough index of feeding activity. Ingram (2001) reports gray trigger to have high site fidelity based on tagging. Therefore, seasonal changes in abundance due to emigration/immigration should not be the cause of changes in CPUE. During the summer months, as both male and female gonosomatic indices (GSI's) of spawning activity peaked, CPUE dropped to its lowest point during the year. After the peak in spawning activity and the observed CPUE minimum, CPUE began to increase, and a spawning check forms as indicated as another translucent band in some spines. The formation of these spawning checks is probably attributable to reproductive behavior. During the spawning season, the territorial male gray trigger prepare a number of nests (see Ingram, 2001 for review). Males then coax females to the nests, not allowing them to leave. Ingram (2001) suggested that this haremic spawning behavior, which has been described for many other species of triggerfishes (e.g., Fricke, 1980; Nellis, 1980; Thresher, 1984; Gladstone, 1994; Ishihara and Kuwamura, 1996; and Kuwamura, 1997), may affect growth of both males and females, possibly leading to the formation of false annuli in the spine. Finally, the annulus is completed when the wide opaque band indicative of fall growth forms in the spine, which is correlated with sustained high levels of CPUE. The formation of the next winter annual mark corresponds with the decrease in CPUE during the winter. With the pattern of annulus formation established, enumeration of annuli and age estimation was straightforward. There also appears to be a settlement mark that forms near the focus in the first dorsal spine of most Alabama gray trigger sampled (~ 89 %). The settlement mark is a translucent ring encircling the focus. Due to the mark's close proximity to the focus, even in small fish (80 – 100 mm fork length) less than 1 year old, it is assumed to be associated with the period of transition between pelagic and demersal habitats. The settlement mark was the only mark in the first dorsal spine resorbed by increased vacularization in larger and older fish, and thus did not affect estimates of age (Ingram, 2001).

2.1.2 Age and Growth Studies

There have been relatively few age and growth studies of gray triggerfish, and results from these studies have differed. Gray trigger growth rate based upon annuli of the first dorsal spine was estimated by Ofori-Danson (1989) off the coast of Ghana in western Africa following a tremendous increase in standing stock biomass there (from ~ 10 kg ha^{-1} in 1968 to ~ 3000 kg ha^{-1} in 1977; Pease, 1984). Ofori-Danson's estimates of the von Bertalanffy parameters were L_∞ = 408 mm and K = 0.43 $year^{-1}$. Johnson and Saloman (1984) conducted a study by sampling the hook and line fishery for gray trigger off the coast of Panama City, Florida. They used methods similar to those reported by Ofori-Danson to estimate size-at-age in the northeastern Gulf, and reported that fish reached a larger maximum length (L_∞ = 466.0 mm) but grew more slowly (K = 0.382 $year^{-1}$) than gray trigger off the West African coast. Wilson et al. (1995) and Hood and Johnson (1997) also studied gray trigger growth in the northern and eastern Gulf, respectively. Wilson et al. (1995) found that estimated ages of gray trigger landed by the commercial fishery in Louisiana ranged from 1 to 11 years, with the majority of the fish sampled being two to six years old. The mean age of females (3.9 years) was slightly, but not significantly, higher than that of males (3.3 years). Also, based on length-frequency data, gray trigger were reported to recruit to the commercial fishery at age 2, with a decline in age-class strength after age 3. Hood and Johnson (1997) studied the age and growth of gray trigger from the eastern Gulf and found that von Bertalanffy growth model (parameters: females, L_∞ = 421 mm, K = 0.329 $year^{-1}$; males, L_∞ = 664 mm, K = 0.156 $year^{-1}$; combined sexes, L_∞ = 645 mm, K = 0.152 $year^{-1}$) tended to underestimate growth when compared to empirical estimates of sizes-at-age. Also, they reported rapid growth in young gray trigger with an average length of 276 mm FL for one-year-old specimens. In addition, Escorriola (1991) sampled both the recreational and the commercial fisheries off the Carolinas on the U.S. east coast and found estimates of growth parameters that differed from those both of Johnson and Saloman (1984) and Hood and Johnson (1997). Escorriola (1991) also used methods similar to Ofori-Danson, and further suggested that gray trigger have a larger maximum length (L_∞ = 571.0 mm) and a slower approach to that maximum length (K = 0.199 $year^{-1}$) than fish off the coast of northwest Florida in the Gulf studied by Johnson and Saloman (1984). Ingram (2001) analyzed 1,628 gray trigger collected for hard-part analysis from the recreational fishery off the Alabama coast. The mean age (± standard error) of males and females collected during this study was estimated to be 3.44 years (± 0.047) and 3.44 years (± 0.039), respectively. Differences in mean ages between male and female gray trigger were not significantly different (ANOVA; $\alpha = 0.05$). The oldest gray trigger in the sample was a female that was estimated to be 8.8 years of age. The oldest male was estimated to be 8.1 years of age (Ingram, 2001). The mean fork lengths (±standard error) of males and females collected during Ingram's (2001) study were estimated to be 361 mm (± 2.17) and 328 mm (± 1.59), respectively. Differences in mean fork length between males and females were significantly different (ANOVA, $\alpha = 0.05$). The von Bertalanffy growth parameters (females, L_∞ = 514 mm, K = 0.208 $year^{-1}$, t_0 = -1.61; males, L_∞ = 598 mm, K = 0.200 $year^{-1}$, t_0 = -1.373; combined sexes, L_∞ = 583 mm, K = 0.183 $year^{-1}$, t_0 = -1.579) indicated that males attain a larger size than females. Hotelling's T^2 statistic indicates a highly significant difference in von Bertalanffy growth functions between males and females (T^2 = 141681.8, $p << 0.001$).

Presently, for SEDAR9, a study combining age and growth data from Hood and Johnson (1997), Ingram (2001), and unpublished age data from gray trigger spines collected throughout the Gulf from 1992-2002 by the NMFS Panama City Lab is currently being conducted. Presently, this study consists of the following data sets:

- Alabama Recreational, 1996-2000, N=1545
- Florida Panhandle Recreational, 1992-1998, N=221
- Florida West Coast Commercial, 1995, 1996, 1998, 2000, 2001 and 2002, N=499
- Florida West Coast Recreational, 1992, 1993, 1995, 1996, 1997, 2000, 2001 and 2002, N=198
- Louisiana Recreational, 1992, 1993, 1994, 1995, 1996, 2000 and 2001 N=184
- Texas Recreational, 1992-1994, N=44
- Summer SEAMAP Groundfish Survey, 1999, N = 71.

Regular or sloped von Bertalanffy growth models were derived for each region/fishery sector category using the trawl captured gray trigger (age-0 and age-1 gray trigger) as an 'anchor' due to the lack age-0 and age-1 gray trigger in the other data sets (Figure 2). Model fit was assessed using residual analyses and corrected R^2. Due to the very high variability in size at age, all data were combined and probabilities of age by 25-mm FL classes were derived (Table 1). Also, age-frequency histograms by year and each region/sector category (Figs. 3-7). Any years with extremely low sample sizes were not shown.

2.2 Reproduction

A study of the reproductive ecology of gray trigger was performed on specimens from Ghana in West Africa (Ofori-Danson, 1990). Ofori-Danson defined the breeding season as October to December by assigning each gonad they collected to one of five gonad maturity categories. Peak spawning occurred in the warmer months, which in Ghana are November and December. First time spawners were 133 - 157 mm in FL, 50.0 - 70.5 g, and one year old. Fecundity (F) was correlated with fork length (FL) and was described by the linear regression log F = 1.176 + 1.642 log FL. In the Gulf of Mexico, there have been a number of studies concerning the reproductive biology of gray trigger. Dooley (1972) estimated the spawning season to be from July to October in the Gulf based upon the presence of small, recently spawned gray trigger in samples. Wilson et al. (1995) reported that ovarian histology indicated that gray trigger captured off Louisiana are iteroparous and spawn during late spring and summer (April through August), with a peak in the gonosomatic index (GSI) in June for both male and female fish. Hood and Johnson (1997) similarly reported iteroparity in gray trigger and suggested that ovarian histology indicated that fish captured off west Florida spawn during summer and early fall (June through September) with a peak in the GSI in August for female fish, and in September for male fish. Mature females with ovaries containing vitellogenic oocytes were first observed in June, and were present through September. Spent females were observed from September through October. From October to March most fish had developing gonads that contained primary growth oocytes and some atretic bodies. Finally, maturing gonads first appeared in April and were present through August in fish from the eastern Gulf (Hood and Johnson, 1997). Hood and Johnson (1997) also report that 87.5% of the female fish were sexually mature by age 1, and no immature males were observed. The smallest mature male observed was 110 mm FL (age 0). Batch fecundities in fish from the eastern Gulf ranged from 213,912 to 1,172,854 oocytes from fish ranging from 267 to 388 mm FL, and relative batch fecundity had a mean of 13,809 oocytes per gram ovary and ranged from 6,318 to 24,188 oocytes per gram (Hood and Johnson, 1997). Ingram (2001) reported that both histological condition of maturity and GSI indicate that spawning activity for both male and female gray trigger from Alabama increases in May, peaks during June and July, and then decreases during August (Figs. 8-10). Sex-specific plots of GSI versus age and fork length provide insight into size and age at maturity for gray trigger (Figs. 11-14). These plots indicate that 1-year-old males (>250 mm fork length) and 2-year-old females (>250 mm fork length) exhibit seasonal maturation cycles associated with spawning. No hydrated oocytes were found in histological sections of females. Therefore, Ingram (2001) enumerated oocytes undergoing final oocyte maturation (FOM) to estimate batch fecundity. Mean diameter (± standard error) of oocytes undergoing FOM was estimated to be 418 μm (± 1). Of the 613 females from which gonads were taken, 59 were observed to be at FOM stage. Of these, 34 were used to estimate batch fecundity. Batch fecundity estimates ranged from 96,379 to 2,649,027 oocytes undergoing FOM per ovary. The mean (± standard error) number of oocytes undergoing FOM per gram was estimated to be 8,015 (± 247). The batch fecundity-fork length relationship (Fig. 15), batch fecundity-age relationship (Fig. 16), and batch fecundity-weight relationship (Fig. 17) all indicated an increase in fecundity with size and age. The mean percent (± standard error) of females spawning per day during the spawning season was 27.3 % (± 4.6). The mean interval between (± standard error) spawnings was estimated to be 3.7 days (± 0.6). Females with ovaries containing oocytes undergoing FOM were observed from late May to late August (~ 90 days). Therefore, the mean number of spawnings (± standard error) per spawning season was estimated to be 24.3 (± 4.1). Mean total annual fecundity (± standard error) was estimated to be 17,071,634 eggs year^{-1} (± 2,010,787).

2.3 Mortality

2.3.1 Previous Studies

Jones (1991) reviewed patterns of mortality in reef fishes and reported that data on mortality are difficult to obtain, and may differ widely among locations. Jones (1986) provided estimates of mortality for juvenile damselfishes *Pomacentrus wardi* and *P. amboinensis*, and mortality rates were greater on shallow reefs than deeper reefs in the same reef area. On a larger scale, mortality rates of red snapper, *Lutjanus campechanus*, tagged above artificial reefs off the Alabama coast differed greatly (i.e. instantaneous fishing mortality ranged from 0.047 to 0.620 year^{-1}) (Watterson, 1998). Watterson (1998) also estimated instantaneous fishing mortality of red snapper inhabiting publicly known reefs off the coast of Alabama and Florida to be much higher (i.e. 1.12 year^{-1}) than the more private artificial reefs off the Alabama coast. Hood and Johnson (1997) estimated instantaneous total mortality of recreationally and commercially caught gray trigger off the west Florida coast to be 0.836 and 0.825 year^{-1}, respectively. Instantaneous total mortality for gray trigger off the coast of Panama City Beach, Florida was estimated to be 0.67 year^{-1} (Johnson and Saloman, 1984). Ingram (2001) estimated instantaneous total annual mortality rate (Z ± standard error) and subsequently annual survival (S ± standard error) to be 0.82 year^{-1} (± 0.08) and 0.44 year^{-1} (± 0.04), respectively, for gray trigger off Alabama. One and two-year-old gray trigger were found to be 7.3 % and 41.4 % recruited, respectively, to the recreational fishery after back calculation. M was estimated to be 0.50 for Alabama gray trigger using Hoenig's method (1983), and F was estimated to be 0.32 (Ingram, 2001).

2.3.2 Total Mortality

From the current study for SEDAR9 of combined data sets, *Z* was derived from the descending limbs of the age-frequency histograms (Fig. 18). Table 2 summarizes the estimates of Z from each region/sector category.

2.3.3 Natural Mortality

Gray triggerfish live to at least 16 years, based on age samples available from the current SEDAR9 study. Based upon this information, the method of Hoenig (1983) results in a value for *M* of 0.27. As this results from a sample taken from an exploited population, the value could be considered somewhat high. Application of this method to the maximum age observed in the age samples from Ingram (2001) results in a maximum value of 0.5, from a sample with a maximum observed age of 8. However, due to the high fishing pressure indicated off Alabama, the estimated *M* of 0.5 is based on data from an age-truncated stock. Therefore, an *M* of 0.5 is probably too high to consider even for a sensitivity analyses. Based upon these observations, it is suggested to use a value of *M* of 0.27 for baseline evaluations, with the range of *M* from 0.2 to 0.4 for sensitivity evaluations.

2.3.4 Fishing Mortality

Using the aforementioned estimate of *M* (i.e., 0.27), estimates of *F* were derived by subtracting *M* from the *Z* of each region/fishery sector category (Table 2). This indicates that the Alabama Recreational sector has a higher *F*, with the Florida West Coast Recreational sector having the lowest.

2.3.5 Release Mortality

For an estimate of acute release mortality, Ingram (2001) visually assessed the condition of the triggerfish upon release after tagging based upon the following scale (Patterson, 1999; Ingram and Patterson, 1999; Patterson and Ingram, 2000): (1) Gray trigger immediately oriented itself toward the bottom and swam down vigorously; (2) Gray trigger appeared disoriented upon entering the water, oriented toward the bottom but swam erratically; (3) Gray trigger appeared very disoriented upon entering the water and remained at the surface; and (4) Gray trigger was either dead or unresponsive upon entering the water. Gray trigger released in a condition other than condition-1 were assigned as having suffered release mortality. Acute mortality of gray trigger due to tagging was estimated to be 1.5 %, but this percentage was statistically significant from zero (Z-test, $p < 0.05$). Out of 1,271 releases (i.e. this included initial releases and subsequent releases after recaptures), four gray trigger were released in condition-2, 14 were released in condition-3 and one was released in condition-4. Out of the 19 gray trigger released in a condition other than condition-1, two (11 %) were recaptured and released again in condition-1, indicating that some proportion of the gray trigger that were assumed to have died as a result of the tagging process actually survived. Also, the probability of occurrence of acute mortality increased slightly with gray trigger size, and the depth of capture did not significantly affect release condition.

2.4 Conversion Factors

Conversion factors for gray trigger are provided in Table 3.

2.5 Stock Recruitment Relationships

The classification scheme developed at the FAO SECOND TECHNICAL CONSULTATION ON THE SUITABILITY OF THE CITES CRITERIA FOR LISTING COMMERCIALLY-EXPLOITED AQUATIC SPECIES (Windhoek, Namibia, 22-25 October 2001; FAO 2001) was used to characterize the relative productivity of gray trigger. This information is provided in Table 4. A productivity rank was assigned to each life-history characteristic (a value of 1 was assigned for low, 2 for medium, and 3 for high productivity characteristics) and the ranks were averaged to produce an overall productivity score. This score was then used to prescribe a prior probability density function on steepness in the stock-recruitment relationship from the periodic life history strategists as summarized by Rose et.al. (2001). The dominant portion of the steepness values from these analogous species range from 0.6-0.8 with 90% of the values less than 0.9. As the gray triggerfish productivity score from this exercise is midway between the medium and high category, it is recommended that the prior probability density function on steepness for this species be lognormal with a mode of 0.8 and a CV such that there is no greater than a 10% probability of steepness values greater than 0.9.

2.6 Habitat

Eggs of Gulf gray trigger incubate in demersal nests between within 12 to 58 hours, after which they enter the plankton (Thresher, 1984). Gray triggerfish are collected in SEAMAP neuston tows, usually associated with seaweed and flotsam (mostly *Sargassum*), at sizes from 2 to 80 mm SL with a median length frequency of 15 mm SL (SEDAR9-DW25). Also, Wells and Rooker (2004) reported the SL of gray trigger associated with *Sargassum* to range from 10 to 80 mm SL, with a mode around 40 mm SL. Ingram (2001) reports that gray trigger settle between 40 and 160 mm FL with a mode around 70 mm FL (i.e., 31 to 130 mm SL, mode 56 mm SL), based on settlement marks in the first dorsal spine of trawl-caught gray trigger. Fork length of gray trigger collected in SEAMAP groundfish surveys ranged from 60 to >280 mm FL with a mode of 90 mm FL during the Summer SEAMAP Groundfish Surveys and a mode of 120 mm FL during Fall SEAMAP Groundfish Surveys. In the Gulf, the gray trigger inhabit reef areas (natural and artificial reefs, low or high-relief reefs) in waters from 10 m (Smith, 1976; Johnson and Saloman, 1984, Ingram, 2001) to 106 m (Kevin Rademacher, pers. comm.[1]) in depth as adults. National Marine Fisheries Service (NMFS) videos taken of reefs in the Gulf indicate that gray trigger are distributed from south Texas around the northern Gulf to just north of the Florida Keys with increased concentration of adults associated with the numerous artificial reef permit areas (Kevin Rademacher, per. comm., SEDAR9-DW21).

2.7 Stock Definition

Adult gray trigger off Alabama exhibit high site fidelity (Ingram, 2001). High site fidelity may result from the territorial nature of adult fish (Ingram, 2001). Bohnsack (1989) infers that fishes

[1] National Marine Fisheries Service, Pascagoula, Mississippi

exhibiting high site fidelity may be more easily overexploited. In the case of gray trigger in Ingram's (2001) study, loss of older age classes resulting from increases in fishing pressure in publicly known fishing grounds is apparent. Selective removal of large, fast-growing members of the population may be resulting in decreased growth rates of survivors on small spatiotemporal scales (Ingram, 2001).

Population parameters of adult gray trigger are heterogeneous on multiple spatial scales. Estimates of growth rates on the scale of individual reefs indicate high variability, which precludes a finding of stock heterogeneity on this small scale (Ingram, 2001). However, at a slightly larger scale (i.e. at the reef-complex or reef-permit-area scale), adult gray trigger appear to have differences in specific population parameters; differences may be attributable to differential fishing pressure between reef areas (Ingram, 2001). On a Gulf-wide scale, temporal differences in growth and mortality parameters may result from different levels of exploitation and/or habitat characteristics, and may preclude any meaningful comparisons of growth and mortality to gain insight into stock structure.

The length of the pelagic phase of young gray trigger is characterized as being prolonged and indeterminate by Richards and Lindeman (1987). Gray trigger may choose to inhabit structure in surface waters until suitable demersal habitat is found, and may be pelagic from a few weeks to several months. Gray trigger associate with *Sargassum* spp. patches and other flotsom during their pelagic phase. Gray trigger may exhibit homogeneous stock structure in relation to genetic variability, due to a prolonged pelagic phase and the potential of wide dispersal (Richards and Lindeman, 1987). However, if young gray trigger are entrained within cyclonic or anti-cyclonic currents that retain them in the same area from which they were spawned, the result would be a mostly self-recruiting population or sub-population. Moreover, comparisons between length-frequency histograms of gray trigger collected as larvae/juveniles in nueston tows during SEAMAP Ichthyoplankton Surveys (SEDAR9-DW25) and gray trigger collected during SEAMAP Groundfish Surveys (SEDAR9-DW23 and SEDAR9-DW27) indicate that many gray trigger probably settle out of surface waters to trawling grounds by late Fall.

3 Commercial Fishery Description, Data Sources, and Statistics

3.1 Commercial Landings Collection and Statistics

3.1.1 Commercial Landings Data Collection

Commercial fishery statistics include information on landings of seafood products, fishing effort, and biological characteristics of the catch. A variety of sources of information are used to obtain these statistics.

The quantity (usually weight) and value of seafood products sold to licensed seafood dealers have been collected through various state and federal programs overtime. Currently these landing statistics are collected by state fisheries agencies in Alabama, Florida, and Louisiana on each fishing trip (trip ticket programs). In Mississippi and Texas, monthly dealer reports of landings are either sent in by the dealer or collected by state and federal port agents. Prior to the implementation of trip ticket programs landings were collected from seafood dealers each month by NMFS and state agents. Trip ticket programs generally provide information on the gear used and the fishing area. For the historical landings obtained from dealers each month, fishing gear and area were assigned by the agents on an annual basis.

At the National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center (SEFSC) commercial landings statistics from North Carolina through Texas from 1962 to present are maintained in a data base referred to as the Accumulated Landings System (ALS). Statistics on all seafood products other than shrimp are maintained in that data base. Landings statistics from before 1962 are maintained by NMFS in Silver Springs, MD.

3.1.2 History and overview of landings data collection

3.1.2.1 Florida

Prior to 1986, commercial landings statistics were collected by a combination of monthly mail submissions and port agent visits. These procedures provided quantity and value, but did not provide information on gear, area or distance from shore. Because of the large number of dealers, port agents were not able to provide the gear, area and distance information for monthly data. Gear, area and distance from shore, however, are provided for annual summaries of the quantity and value and known as the Florida Annual Canvas data.

Beginning in 1986, mandatory reporting by all seafood dealers was implemented by the State of Florida. The state requires that a report (ticket) be completed and submitted to the state for every trip from which seafood was sold. Dealers have to report the type of gear as well as the quantity (pounds) purchased for each species. Information on the area of catch can also be provided on the tickets for individual trips. As of 1986 the ALS system relies solely on the Florida trip ticket data to create the ALS landings data for all species other than shrimp.

3.1.2.2 Alabama

Until the year 2000 data collection in Alabama was voluntary and was conducted by state and federal port agents that visit dealers and docks monthly. Summaries of the total landings (pounds) and value for species or market category were recorded. Port agents provided information on gear and fishing area from their knowledge of the fisheries and interaction with fishermen and dealers. As of mid- 2000 the State of Alabama required fishermen and dealers to report all commercial landings data through a trip ticket system. As of 2001 the ALS system relies solely on the Alabama trip ticket data to create the ALS landings data for Alabama.

3.1.2.3 Mississippi

Data collection in Mississippi is voluntary and is conducted by state and federal port agents that visit dealers and docks monthly. Summaries of the total landings (pounds) and value for species or market category are recorded. Port agents provide information on gear and fishing area from their knowledge of the fisheries and interaction with fishermen and dealers.

3.1.2.4 Louisiana

Prior to 1993, commercial landings statistics were collected in Louisiana by federal port agents following the traditional procedures established by the NMFS. Monthly summaries of the quantity and value were collected from each dealer in the state. The information on gear, area and distance from shore were added by the individual port agents.

Beginning in January 1993, the Department of Wildlife and Fisheries, State of Louisiana began to enforce the states' mandatory reporting requirement. Dealers have to be licensed by the state and are required to submit monthly summaries of the purchases that were made for individual species or market categories. With the implementation of the state statute, federal port agents did not participate in the collection of commercial fishery statistics.

After the implementation of the state program, information on the gear used, the area of catch and the distance from shore has not been added to the landings statistics (1992-1999). In 1998 the State of Louisiana required fishermen and dealers to report all commercial landings data through a trip ticket system. This data contains detailed landings information by trip including gear, area of capture and vessel information. As of 2000 the ALS system relies solely on the Louisiana trip ticket data to create the ALS landings data for Louisiana.

3.1.2.5 Texas

The state has mandatory reporting requirement for dealers licensed by the state. Dealers are required to submit monthly summaries of the quantities (pounds) and value of the purchases that were made for individual species or market categories. Information on gear, area and distance from shore are added to the state data by SEFSC personnel.

3.1.2.6 Inter-State Transport

Often seafood products are landed in one state and transported by the purchasing dealer to another state; such landings may be recorded both in the state of landing and where the purchasing dealer is located. State and SEFSC personnel track these landings to assure that double counting does not occur and assign them to the state of landing.

3.1.3 Commercial Landings Data Base Organization and Data Handling

The data are organized into three primary components: historical annual data (1962-1976), monthly data (1977-present) and Florida annual data (1976-1996). The monthly 1977-present data for Florida does not have gear or fishing area for the period 1977-1996, while the annual Florida data (1976-1996) has gear and fishing area information which was provided by port agents based on their knowledge of the fisheries.

3.1.3.1 Accummulated Landings System (ALS)

1962-1976 Annual Landings by Year, State, County, Area, Gear, and Species for Florida West Coast through Texas.

1977-present Monthly Landings by Year, Month, State, County, Area, Gear, and Species for Florida West Coast through Texas. Data reported from some states do not have information on the area and gear of capture particularly during the 1990s.

Historically the state and county recorded in the ALS indicates where the marine resource was landed. However in recent years (with the advent of trip tickets as the source of the landings data) in some states the state and county reflect the location of the main office of the purchasing dealer..

Fishing takes place in many different regions including United States waters of the Gulf of Mexico, the South Atlantic and in foreign waters. For the years 1976-present the area codes assigned to those regions are:

- South Atlantic catch in the ALS is considered all area codes 0010, 0019, and 7xxx and higher.
- Foreign Waters are area codes 022x- 060x and 186x.
- In order to define the area of capture for Florida West coast for years 1976-1996 previous assessments use the Florida Annual Canvass data set. (Note* -The State of Florida implemented their trip ticket program in 1985 with more complete reporting starting in 1986. This data set was to contain area of capture information, but due to the nature of a public reporting, some fields on the ticket (such as area) may not have been reported consistently or completely in the early implementation years.)

3.1.3.2 Florida Annual Canvas Landings

1976-1996 - Florida Annual Canvass for area and gear estimates by county which are not in the Monthly Landings for Florida West Coast.

The Florida Annual Data files from 1976 – 1996 represent annual landings by county(from dealer reports) which are broken out on a percentage estimate by species, gear, area of capture, and distance from shore. These estimates are submitted by Port agents, which were assigned responsibility for the particular county, from interviews and discussions with dealers and fishermen collected through out the year. The estimates are processed against the annual landings totals by county on a percentage basis to create the estimated proportions of catch by the gear, area and distance from shore.(The sum of percentages for a given Year, State, County, Species combination will equal 100.)

<u>Florida Annual Canvass 1976-1996 considerations:</u>

- 1976-1985 Data is as landed weight which for amberjack and vermilion snapper was normally landed in a gutted condition. In order to convert to whole weight a factor of 1.04 is universally applied for amberjack and 1.11 for vermilion. Gray Trigger fish is normally landed whole.

- All Area codes 0010, 0019, and 7xxx and higher are considered South Atlantic catch

- State 00 and Grid 0000 in the data set are marine product landed else where and trucked into the State of Florida and are considered duplicated else where because they are theoretically reported back to the state of landing and are not included in the Florida totals.

- State 12 is in the data set which represent Florida interior counties which were landed on Florida East Coast and not included in the Gulf catches.

3.1.3.3 Assignment of gear and area of capture 1990-present

The gear and fishing area designations in the landings data base has been provided by a variety of sources including port agents (annual and/or monthly landing reports), dealers (some trip ticket reports) and permit applications (some trip ticket reports, used only for gear). For some states the fishing gear and area were not reported when trip ticket programs were initiated. Beginning in 1990 fishermen have provided log books which indicate fishing gear, and area as well as catch and effort. The working group recommended that starting in 1990, landings be classified by gear and area using year and state specific information from logbooks.

3.1.4 <u>Commercial Landings</u>

3.1.4.1 Commercial landings by State

Commercial landings in pounds by state and year are shown in Table 5. Those landings are shown for landings reported as for gray triggerfish and unclassified triggerfish. The panel chose to consider both of these categories as gray triggerfish (see below).

3.1.4.2 Commercial Landings Species Composition

In the ALS four codes for for unclassified triggerfish and three triggerfish species have been used. Prior to 1993 only unclassified triggerfish was recorded. Starting in 1993 landings were recorded for gray triggerfish, ocean triggerfish, and queen triggerfish as well as unclassified triggerfish. Since 1993 gray triggerfish has accounted for nearly all of the landings.

Consequently, the assumption is made that those landings belonging to the unclassified triggerfish were gray triggerfish. (SEDAR9-DW13).

3.1.4.3 Commercial Landings for Assessment by State

Commercial landings by state are shown in Table 6.

3.1.4.4 Commercial Landings for Assessment by Gear and Area

Table 7 shows commercial landings by gear and region. For landings from 1990-2004 gear and statistical area were assigned from log books by year and state. The eastern and western regions were separated at approximately the Mississippi River with east including statistical areas 1-12 and the west including areas 13-21. Longline included vertical longline, trap included all pot and trap gears and handline included all other gears.

3.2 Bycatch

3.2.1 <u>Commercial Finfish Fishery Discards</u>

Estimates of gray triggerfish commercial discards were presented in SEDAR9-DW17. A 20% sample of the vessels with a Gulf of Mexico reef fish, king mackerel, Spanish mackerel or shark permit were selected to report discards. Data were available for the period August, 2001 through December, 2004. There were only about 50 trips on which gray triggerfish were reported. As a result, there were not sufficient data to conduct generalized linear modeling (GLM) analyses for gray triggerfish. Instead, the data were solely stratified by time of year (Jan-Jul or Aug-Dec).

The estimated number of discards was calculated by multiplying the number of trips in a statum by the average catch rate in the stratum. Estimates were made only for the handline fishery (included electric reel and hydraulic ‘bandit rig’ gear) due to small sample sizes of discards reported from other gears. Additionally estimates were calculated for years before the discard program was initiated. These were made using the 2001-2004 average discard rates for each stratum. These pre-July 2001 estimates were made only for periods when the size limit was the same as the size limit in 2001-2004. Since a size limit was enacted for gray triggerfish in late November, 1999, estimates were made starting in 2000 (Fig. 19).

The committee reviewed existing data which might be useful in estimating the average weight of discards. The committee suggested that the average size of discards might be estimated from information on the compostion before and after minimum sized restrictions were imposed. A review of the gray triggerfish data before and after 2000 indicated no differences in the size composition with very few fish below the minimum size; therefore the committee suggested that the weight associated with the minimum size might be used.

3.2.2 <u>Shrimp Fishery Bycatch</u>

The Bayesian techniques used to estimate shrimp fleet bycatch for red snapper during SEDAR7 (SEDAR7-DW3 and 54) were applied to vermilion snapper, gray triggerfish, and greater amberjack in SEDAR9-DW26. Results for all three species do not appear to be as reliable as the results for red snapper, probably in large part due to their lower abundances, but also due to reasons unique for each species. Gray triggerfish have a relatively even distribution and are probably abundant enough for a reasonable analysis, but the species was not on the list of 22 species for which data were to be recorded during “Evaluation Protocol” observer trips. Hence, shrimp observer data relevant to gray triggerfish are very, very sparse. It was not possible to obtain an estimate for bycatch with BRDs for triggerfish with the Bayesian model. Because of doubts about the reliability of the annual estimates for these species from the SEDAR7 model, a delta distribution-based version of the Bayesian approach was introduced, and a fully mixed effects model (“Model 3”) was resurrected. The mixed model had been considered for red snapper but was ultimately rejected. There is some evidence that the delta implementation may underestimate bycatch, while Model 3 central tendencies tended to be intermediate between the SEDAR7 and delta results, but the uncertainty estimates were enormous. Table 9 provides some summary statistics of the performances of the models when applied to gray triggerfish, and compare them with the more successful situation for red snapper. In view of the unrealistic results that cropped up for all three SEDAR9 species, the DW recommends setting aside the estimates of interannual variation in favor of estimating an overall average, and then constructing wide uncertainty intervals to incorporate estimation error within models, variation among model choices, and interannual variation. Working at a resolution below an annual time step is not recommended. The simplest statistic from SEDAR9-DW26 (average CPUE in all observer trips times an approximate recent effort level) is recommended as the estimate of central tendency. It was not possible to partition the bycatch estimates by age as per SEDAR7-AW20, as only a handful of fish for these 3 species have been measured across all the observer studies.

The recommended central tendency for shrimp fleet bycatch for gray triggerfish is 3.8 million fish per year.

3.3 Size composition

SEDAR9-DW-11 presented information on the size composition of gray triggerfish caught in commercial fisheries. The report showed that trap caught fish were generally smaller than fish caught by handlines and that fish caught by other gears (primarily longline were generally larger than fish caught by handlines. The report also showed that the relatively small number of fish measured from statistical areas 2-5 tended to be larger than the fish caught in the other areas. The committee recommended that if catch at age was to be estimated from size composition samples that stratification be used to account for these differences; it was noted that sample sizes were low particularly for the other gear category and for statistical areas 2-5, so that there were probably not be sufficient samples to adequately characterize the annual size composition for those strata.

4 Recreational

The recreational fishery statistics for gray triggerfish are collected by three separate surveys: Marine Recreational Fishing Statistical Survey (MRFSS), Texas Parks and Wildlife Department (TPW) and the Headboat Survey (HB). MRFSS captures statistics on shore based, charter boat and private/rental boat fishing since 1981 from Florida through Louisiana. MRFSS included headboats in the survey from 1981-1985. HB began in 1986 from Florida through Texas. TPW collects recreational fishing statistics for all fishing modes except headboats in the state of Texas.

This group expressed concern over the accuracy of the MRFSS data for the reef fish species. The group agrees that these three species are major components of the recreational fishery. The group's concern centers on the low number of intercepted fish that is used in conjunction with the fishing effort estimates from the phone survey to estimate total catch (e.g., small anomalies in the data can be expanded to large anomalies). Another concern is over species identification by contract port agents in the early years of the survey and by fisherman for the B1 and B2 catches. Species identification is the greatest issue for the jack family. The group decided that MRFSS provides the best available data at this time. The relatively high CVs associated with the landings will be incorporated into the assessment models.

> **Group Decision:** The MRFSS data is the best available data and cannot be ignored. The landings have CVs associated with them which will capture the high level of uncertainty.

<u>MRFSS</u>

1. The MRFSS data has missing information for landings in some years, waves, or states that need to be filled with some value.

   Group decision: Staff of NMFS SEFSC are developing methodology by which to fill in the missing landings information. The missing landings are most commonly from the first wave in 1981 and Texas for all years. The group decided to accept the methodology from the SEFSC staff (Appendix 1). The group was not able to review the methodology at the time of the data workshop.

<u>Headboat</u>

1. Headboats have no estimates of released fish.

   Group Decision: Use the rate of B2 from MRFSS charter boat mode only. The group felt that charter boat and headboat fishing is most similar and the rate of released fish would be most like. Private boat fishing would not be the same as the "for-hire" sector.

2. Headboat landings from the Florida Keys and Atlantic based trips to the Dry Tortugas (areas 12 and 17):

   Group Decision: The group should not be included in the Gulf of Mexico analysis. The group felt that better than 99% of the trips in area 12 and 17 are in Atlantic jurisdiction.

5 Fishery-Dependent Survey Data

5.1 Commercial Fishery Catch Rates

5.1.1 Commercial Handline

An abundance index was developed for Gulf of Mexico gray triggerfish using data from the National Marine Fisheries Service (NMFS) reef fish commercial logbook program when handline or electric reel gear was used (SEDAR9-DW30). This index spanned from 1993 to 2004, with good sample sizes throughout. Gray triggerfish was the 6th most common species in the Gulf of Mexico MRFSS dataset but occurred in 23% of trips. The Stephens and MacCall (2004) species association approach was used to identify trips that were likely to catch gray triggerfish based on the composition of other species landed. This approach selected 32,119 trips for consideration, and gray triggerfish occurred in 19,575 (61%) of them. Nominal CPUEs from these trips indicated that gray trigger may have declined over the time series. Using these trips, a delta-lognormal model was constructed considering the following factors: year, season, red snapper season, red snapper permit (class 1 or not), hooks per line, and state. The model identified year, state, and red snapper permit as significant on the binomial portion of the model, and year, hooks per line, state, state*hooks, and year*state in the lognormal portion. The resulting standardized index suggested the stock had generally increased over the time period, with relatively good confidence throughout the time period (Table 10; Fig. 20). This index will be reconstructed after including a relatively small number of unidentified gray triggerfish. These are most likely gray triggerfish and will most likely only make a small difference in the results. Additionally, concern was raised about whether hook-hours was the appropriate measure of effort for this fishery, especially considering the significance of hooks per line in the analysis. Consequently, effort will be paid to examining this and an alternative measure of effort, line-hours.

5.2 Recreational Fishery Catch Rates

5.2.1 Marine Recreational Fisheries Statistics Survey Catch Rates

An abundance index was developed (SEDAR9-DW28) for Gulf of Mexico gray triggerfish using data from the Marine Recreational Fisheries Statistics Survey (MRFSS). MRFSS data include fish landed and observed by the interviewer (A), dead fish not observed by the interviewer (B1; e.g., unavailable, filleted, used for bait, discarded dead at sea) and fish released alive (B2). Since the indices were estimated on the total catch (A+B1+B2) instead of on landings, it is expected that any impact of size limits would be minimized. This index spanned from 1981 to 2004, although data prior to 1986 was based on few sample sizes. Although there were many trips in the MRFSS system, many caught few species and so no species occurred frequently in trips. Gray triggerfish was the 13th most common species in the Gulf of Mexico MRFSS dataset but occurred in only 6.7% of trips. The Stephens and MacCall (2004) species association approach was used to identify trips that were likely to catch gray triggerfish based on the composition of other species caught. This approach selected 7,248 trips for consideration, and gray triggerfish occurred in 4,308 (59%) of them. Nominal CPUEs from these trips indicated that gray trigger may have increased over the early part of the time series and declined more recently. Using these trips, a delta-lognormal model was constructed considering the following factors: year, season, red snapper season, state, and mode. The model identified year, mode, and state as significant on the binomial portion of the model, and year, season, state, red snapper season, year*state, and year*season in the lognormal portion. The resulting standardized index suggested the stock had increased and then declined over the time period, with greater confidence on the recent observations than the older ones (Table 10; Fig. 21). This index will be reconstructed after including a relatively small number of unidentified gray triggerfish. These are most likely gray triggerfish and could make a difference in the early years of the survey, when sample sizes were generally low.

5.2.2 Headboat Survey Catch Rates

An abundance index was developed (SEDAR9-DW29) for Gulf of Mexico gray triggerfish using data from the NMFS Southeast Zone Headboat Survey. This index spanned from 1986 to 2003, with large sample sizes each year. Additionally, vessels could be tracked individually. Gray triggerfish was the most common species in the Gulf of Mexico headboat dataset and occurred in 46% of trips. The Stephens and MacCall (2004) species association approach was used to identify trips that were likely to catch gray triggerfish based on the composition of other species landed. This approach selected 64,006 trips for consideration. These were further limited to vessels that had at least 30 trips within the species association dataset. This restriction eliminated 58 of 161 vessels (36%) but only 615 trips (1%). Gray triggerfish occurred in 74% of the retained trips. Nominal CPUEs from these trips indicated that gray trigger may have increased over the early part of the time series and declined more recently. Using these trips, a delta-lognormal model was constructed considering the following factors: year, season, state, vessel, time of day, and trip duration. The model identified year, state, and year*state in the binomial portion and year, vessel, season, year*vessel, and year*season in the lognormal portion. Vessel was also significant in the binomial portion of the model and the season*vessel interaction in the lognormal portion. However, inclusion of these factors prevented the model from converging, so they were withheld. The resulting standardized index suggested the stock had increased and then declined over the time period, with fairly good confidence across all observations (Table 10; Fig. 22). This index will be reconstructed with data from 2004 when those data are available. Additional effort may also be paid to incorporating the vessel terms that caused convergence problems.

5.3 Recommendations

5.3.1 Indices to be considered for use in the assessment

As a general recommendation, each of these indices is recommended for use pending the expected revisions to the analyses and input data. Their relative values are shown for comparison in Fig. 23.

5.3.2 Data and/or analysis revisions

Investigations will be made into the appropriate measure of effort in the commercial handline analysis, and revisions made if necessary. The unidentified triggerfish will be included as gray triggerfish for both the commercial handline analysis and the MRFSS analysis.

Data are now available from the Headboat Survey in 2004. These should be incorporated in the headboat analysis prior to the assessment.

The question of whether or not size limit changes may have impacted the indices should be considered, incorporating information such as size frequency distributions, and included in the paper(s).

6 Fishery-Independent Survey Data

In preparation for the SEDAR, four fishery independent surveys were analyzed and indices of relative abundance developed. These were the Southeast Area Monitoring and Assessment Program (SEAMAP) shrimp/bottomfish surveys and their predecessors, the SEAMAP ichthyoplankton surveys, the SEAMAP reef fish survey, and the small pelagics trawl survey. The small pelagics data may be useful for extended distributional information, but is not a rigorous time series, and is not considered further here. The ichthyoplankton and reef fish surveys are intended to index spawning stock size. The trawl indices are intended to index new recruitment.

6.1 SEAMAP Ichthyoplankton Surveys

Examination of proportion occurrence and nominal mean abundance of gray triggerfish larvae captured during all SEAMAP surveys indicated that larvae consistently occurred most frequently and in highest abundance in neuston net samples during the annual Fall Plankton survey. Gray triggerfish occurred more frequently and were caught in higher numbers in this survey when compared to summer and fall shrimp/bottomfish surveys. Additionally, this is the only established SEAMAP survey that samples the entire spawning grounds of gray triggerfish in the U.S. Gulf of Mexico. The time series of larval data available for the upcoming assessment includes the years, 1986-2002 with 1998 observations excluded due to curtailed sampling that year. Catches of gray triggerfish larvae from sampling during the summer and fall shrimp/bottomfish surveys were not included in estimates of annual abundance because these surveys do not extend east of Mobile Bay, Alabama and, therefore, do not adequately sample the gray triggerfish spawning stock. It is evident from a comparison of mean annual abundances, coefficients of variation of mean abundance (CV), and annual proportion occurrence in the two plankton gear types that gray triggerfish larvae are taken more consistently in neuston than in bongo samples. CV's over the time series for neuston net catches are lower and relatively more stable than for bongo net catches. We recommend that the gray triggerfish index of larval abundance be based on neuston net samples from the SEAMAP Fall Plankton survey. This index, as reported in working document SEDAR9-DW25, should be considered a nominal or raw index only.

Two sampling issues were discussed by the workgroup that need addressing before standardized larval indices are constructed and evaluated. The first was duplicate and/or multiple sampling at some SEAMAP systematic grid sites, and the second, was gaps in spatial coverage over the survey area. Two methods to mitigate any potential bias in survey indices caused by variable spatial coverage were discussed. First was a two step process to filter sample sites used to estimate larval abundance. Step one deletes duplicate samples at a systematic grid site, retaining a single sample at each grid site in accordance with SEAMAP sample design. Priority is given to samples collected by NMFS vessels since these vessels generally collect the majority of survey samples overall, and then to the sample nearest the actual grid site. The second step deletes any sites on the systematic grid not sampled during at least 75% of years in the time series resulting in a more consistent area of coverage over the time series.

The workgroup also briefly discussed the need to construct an age or size corrected index due to inter-annual differences in size (age) composition of young gray triggerfish over the index time series. An attempt will be made, as time permits, to construct a size adjusted index (as described in Hanisko et al. SEDAR7-RW-7). The final step will be construction of a model based larval abundance index using the delta-lognormal approach (Lo et al., 1992). Joanne Lyczkowski-Shultz will provide the final indices prior to the August stock assessment.

6.2 SEAMAP Reef Fish Survey

The SEAMAP reef fish survey employs video cameras to estimate the abundance offish associated with reefs and banks located on the continental shelf of the Gulf of Mexico. Fish traps are also employed to capture fish for aging. Details of survey design and estimates of abundance for gray triggerfish are in the working paper (SEDAR9-DW21). We recommend the use of design-based estimates of abundance for gray triggerfish. There was no advantage to using the model-based estimates because no gaps were present in the survey time series that could be accounted for using a GLM approach. The size of the fish observed during the survey come from two sources, fish captured in traps and fish measured on video tape with lasers. Lasers were first introduced in 1995. However, since both the capture of fish in traps, and the instances where fish are hit by lasers was infrequent, size distributions were not estimated. We report only the average size and size range of fish. Survey indices are in working paper SEDAR9-DW21 and presented in Table 11 and Fig. 24. The size of gray triggerfish observed ranged from 123 mm FL to 623 mm FL. Therefore the video survey observes fish age 1+. The results of a 2004 survey will be added. These will be provided prior to the August stock assessment by Chris Gledhill, NMFS Pascagoula, MS.

6.3 SEAMAP Trawl Surveys

The procedures used in SEDAR7 to derive trawl survey indices of abundance for red snapper (SEDAR7-DW1 and DW2; and the age composition portion of SEDAR7-AW15) were applied to gray triggerfish, and reported in SEDAR9-DW27. A Bayesian modeling procedure is used to combine different survey designs from different time series to create a Fall index for 1972-2004 (Table 11, Fig. 25), and a summer index for 1981-2004 (Table 11, Fig. 26) based on the SEAMAP standard. Standard SEAMAP surveys are conducted between 5 and 50 fm, from Mobile Bay to the Mexican border. Within the survey area, gray triggerfish are abundant and frequent enough for derivation of meaningful indices. Triggerfish occur east of the survey area as well; where the rough, live bottom makes standard surveys impractical. Sporadic observations in the eastern Gulf suggest triggerfish catch rates there may comparable to those within the survey area, so a substantial fraction of the population probably is covered, even though the total range cannot be. Size composition data are available for 1987 forward. There appear to be at least two peaks in the summer size composition, but one broad peak in the fall size composition.

A temporary working group consisting of age / growth, larval index, and trawl index specialists met during the Data Workshop to interpret the size compositions from the SEAMAP trawl surveys collected in SEDAR9-DW-18, concentrating on the plots made from fish from all years, combined. Size data are available from 1987 forward.

For gray triggerfish in the summer, size data combined over years showed two overlapping peaks. Imposing a boundary at 140 mm would results in a reasonable separation, very consistent with a sharp transition between ages 0 and 1 from aged fish from all sources combined. (Direct ageing of trawl catches alone exist, but only for about 80 fish in one year.) The peak of smaller fish are clearly young of the year, but most of the seasonal recruitment is yet to come. Therefore, the interannual variations of fish under 140 mm are probably not suitable for describing variations in year class strength. Fish above 140 mm are interpreted as age 1+. Age 1 and 2 are known to overlap broadly in size. There are also indications of strong selection by size among gear – fish aged 1 taken in the directed fisheries are substantially larger than trawl-caught age 1s.

In the fall, only a single peak is evident. The catch is almost certainly dominated by age 0s. Based on larval CPUE patterns, recruitment to the trawls is probably substantially complete in time for the fall survey. (Triggerfish are known to be able to remain in the plankton for extended periods, but we founding nothing to indicate that any substantial fraction of the population follows that path.) We did not see a basis for extracting separate classes from the single peak. The fall survey index could probably treated in the assessment as either an index of age 0 with minor error from contamination of older fish, or of age 0+ without internal information on age selectivity.

In red snapper (SEDAR7-AW15), it was possible to establish age 0 / age 1 boundaries that varied over years. (The annual size compositions were not ambiguous for that more abundant species.) There are some cases of apparent shifting in the annual plots in SEDAR9-DW-18, but on an annual basis, the data become quite sparse. We decided to recommend against changing age 0 / age 1 boundaries among years. Such a procedure would probably add more noise than signal. Scott Nichols will provide the age composition vectors prior to the August stock assessment.

6.4 Summary of Outstanding Items

In summary, fishery independent index items still outstanding, but slated for completion prior to the SEDAR9-AW in August are: final larval indices (Lyczkowski-Shultz); updated reeffish indices (Gledhill), and trawl index age compositions (Nichols).

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8 Tables

Table 1—Probability of Age Given Length Class

Probability of age for various fork length classes for Gulf gray triggerfish.

Prob SE	Fork Length Class (mm)																			
Age Class (years)	**100-124**	**125-149**	**175-199**	**200-224**	**225-249**	**250-274**	**275-299**	**300-324**	**325-349**	**350-374**	**375-399**	**400-424**	**425-449**	**450-474**	**475-499**	**500-524**	**525-549**	**550-574**	**575-599**	**600 +**
0	1.000	0.000	0.002	0.000	0.001	0.119	0.053	0.009	0.004	0.004	0.003	0.005	0.004	0.003	0.006	0.007	0.004	0.007	0.007	0.001
	0.007	0.000	0.021	0.004	0.005	0.030	0.017	0.006	0.003	0.003	0.005	0.005	0.005	0.009	0.016	0.003	0.013	0.003	0.003	0.015
1	0.000	0.978	0.002	0.605	0.122	0.208	0.185	0.176	0.117	0.057	0.048	0.010	0.013	0.003	0.006	0.007	0.005	0.032	0.007	0.001
	0.000	0.148	0.018	17.143	0.025	0.039	0.045	0.072	0.035	0.012	0.055	0.007	0.010	0.009	0.016	0.003	0.004	0.011	0.003	0.015
2	0.000	0.022	0.525	0.395	0.267	0.289	0.269	0.294	0.297	0.190	0.143	0.130	0.038	0.031	0.007	0.008	0.005	0.008	0.008	0.002
	0.007	0.148	0.044	17.165	0.051	0.043	0.063	0.118	0.083	0.021	0.162	0.024	0.017	0.064	0.017	0.003	0.005	0.003	0.003	0.214
3	0.000	0.000	0.466	0.000	0.116	0.154	0.205	0.215	0.188	0.315	0.305	0.248	0.160	0.142	0.142	0.034	0.039	0.008	0.007	0.002
	0.000	0.000	0.043	0.003	0.024	0.034	0.049	0.087	0.054	0.025	0.342	0.031	0.033	0.287	0.342	0.013	0.039	0.003	0.003	0.017
4	0.000	0.000	0.002	0.000	0.152	0.097	0.105	0.136	0.179	0.188	0.192	0.267	0.314	0.205	0.219	0.129	0.093	0.155	0.088	0.198
	0.000	0.000	0.011	0.003	0.065	0.028	0.028	0.056	0.052	0.021	0.215	0.031	0.042	0.413	0.527	0.045	0.059	0.065	0.042	2.131
5	0.000	0.000	0.001	0.000	0.228	0.084	0.096	0.094	0.105	0.105	0.134	0.155	0.172	0.296	0.232	0.268	0.156	0.099	0.224	0.218
	0.000	0.000	0.004	0.003	0.079	0.026	0.026	0.040	0.032	0.016	0.151	0.026	0.034	0.596	0.558	0.060	0.074	0.040	0.083	2.353
6	0.000	0.000	0.001	0.000	0.112	0.024	0.070	0.044	0.083	0.070	0.076	0.047	0.110	0.142	0.197	0.170	0.304	0.181	0.224	0.198
	0.000	0.000	0.008	0.003	0.071	0.014	0.021	0.020	0.026	0.014	0.086	0.015	0.028	0.287	0.473	0.051	0.094	0.069	0.083	2.130
7	0.000	0.000	0.001	0.000	0.001	0.009	0.012	0.022	0.013	0.036	0.059	0.082	0.136	0.099	0.132	0.157	0.133	0.065	0.125	0.001
	0.002	0.000	0.018	0.000	0.006	0.009	0.214	0.386	0.227	0.010	0.972	0.019	0.031	1.570	2.011	0.049	0.069	0.044	0.066	0.102
8	0.000	0.000	0.001	0.000	0.001	0.004	0.002	0.004	0.008	0.012	0.024	0.028	0.020	0.057	0.036	0.075	0.133	0.099	0.156	0.153
	0.002	0.000	0.018	0.000	0.006	0.006	0.002	0.003	0.141	0.006	0.417	0.012	0.013	0.948	0.607	0.036	0.069	0.054	0.073	9.111
9	0.000	0.000	0.001	0.000	0.000	0.009	0.003	0.003	0.003	0.005	0.011	0.018	0.020	0.014	0.013	0.054	0.093	0.099	0.006	0.001
	0.000	0.000	0.001	0.002	0.005	0.009	0.003	0.003	0.002	0.004	0.014	0.009	0.013	0.029	0.034	0.030	0.059	0.054	0.010	0.025
10+	0.000	0.000	0.001	0.000	0.001	0.004	0.002	0.003	0.003	0.017	0.004	0.011	0.014	0.009	0.012	0.091	0.036	0.246	0.149	0.225
	0.000	0.000	0.000	0.005	0.000	0.002	0.001	0.002	0.001	0.007	0.004	0.007	0.010	0.019	0.029	0.031	0.034	0.064	0.056	2.428

Table 2—Mortality Estimates by Location from Catch Curves

Total and fishing mortality with 95% confidence limits.

State-Sector	*Z*	LCL*Z*	UCL*Z*	*M*	*F*	LCL*F*	UCL*F*
AL recreational	0.6477	0.4339	0.8614	0.27047	0.37720	0.16342	0.59097
FL Panhandle recreational	0.4070	0.2438	0.5701	0.27047	0.13651	-0.02665	0.29968
FLWest Coast commercial	0.4022	0.2868	0.5176	0.27047	0.13170	0.01629	0.24711
FL West Coast recreational	0.3432	0.2055	0.4809	0.27047	0.07275	-0.06492	0.21042
LA recreational	0.5555	0.3562	0.7548	0.27047	0.28501	0.08568	0.48434
TX recreational	0.4083	0.2786	0.5379	0.27047	0.13779	0.00818	0.26740

Table 3—Morphometric Conversions

Various morphometric conversion factors by source.

Region	Y	X	Sex	Equation	r^2	n
Alabama (Ingram 2001)	TL(mm)	FL(mm)	pooled	Y=-10.5017 + 1.1889X	0.96	2873
	Weight(kg)	FL(mm)	male	$Y=(1.566\times10^{-8})(X)^{3.0616}$	0.99	748
	Weight(kg)	FL(mm)	female	$Y=(1.792\times10^{-8})(X)^{3.0457}$	0.99	775
	Weight(kg)	FL(mm)	pooled	$Y=(2.039\times10^{-8})(X)^{3.0203}$	0.99	1533
FL West Coast (Hood and Johnson 1997)	TL(mm)	FL(mm)	pooled	Y=-2.6 + 1.13X	0.99	854
	FL(mm)	TL(mm)	pooled	Y=3.4 + 0.88X	0.99	854
	Weight(g)	Gutted Weight(g)	pooled	Y=-11.8 + 1.15X	0.99	89
	$\log_{10}$Weight(g)	$\log_{10}$TL	pooled	$\log_{10}(Y)=-4.60 + 2.87\log_{10}(X)$	0.91	646
	$\log_{10}$Gutted Weight(g)	$\log_{10}$TL	pooled	$\log_{10}(Y)=-5.01 + 3.03\log_{10}(X)$	0.99	170

Table 4—Metaanalytic Approach to Life History Parameters
Proposed guideline indices of productivity for exploited fish species based on meta-analysis of similar species.

Parameter	**Productivity**			**Species**
	Low	**Medium**	**High**	Gray Triggerfish
M	**<0.2**	**0.2 - 0.5**	**>0.5**	0.2, **0.27**, 0.5
K	**<0.15**	**0.15 - 0.33**	**> 0.33**	**0.43**
t_{mat} (years)	**> 8**	**3.3 - 8**	**< 3.3**	**1**
t_{max} (years)	**>25**	**14 - 25**	**<14**	**16**
Examples	orange roughy, many sharks	cod, hake	sardine, anchovy	Gray Triggerfish Productivity Score = 2.5 (HighMedium)

Table 5—Commercial Landings (pounds) by Year, State, and Species/Group from all waters (Gulf of Mexico, Atlantic, Caribbean)

	triggerfish unclassified							gray triggerfish							
	TX	LA	MS	AL	wFL	eFL	subtotal	TX	LA	MS	AL	wFL	eFL	subtotal	total
1963					11,500	6,900	18,400								18,400
1964					24,000	5,600	29,600								29,600
1965					25,700	2,200	27,900								27,900
1966					13,900	1,600	15,500								15,500
1967					17,400	3,500	20,900								20,900
1968					12,500	3,300	15,800								15,800
1969					22,300	1,700	24,000								24,000
1970					24,200	2,300	26,500								26,500
1971					40,400	5,300	45,700								45,700
1972					62,600	9,300	71,900								71,900
1973					53,200	9,900	63,100								63,100
1974					54,000	17,600	71,600								71,600
1975					78,000	35,000	113,000								113,000
1976					84,500	21,700	106,200								106,200
1977					59,386	20,801	80,187								80,187
1978					58,823	27,818	86,641								86,641
1979					101,403	26,628	128,031								128,031
1980					96,529	17,129	113,658								113,658
1981					89,860	9,876	99,736								99,736
1982					96,673	7,666	104,339								104,339
1983				2,670	71,360	18,180	92,210								92,210
1984		32		14,694	55,450	21,078	91,254								91,254
1985	336	4,766	25	11,840	75,961	23,777	116,705								116,705
1986	572	14,493	4,008	5,881	70,978	17,601	113,533								113,533
1987	289	21,941	5,550	3,778	92,742	16,979	141,279								141,279
1988	1,885	36,980	8,242	7,641	140,790	29,477	225,015								225,015
1989	429	60,856	7,682	10,389	238,974	50,063	368,393								368,393
1990	6,951	69,798	9,027	16,613	359,553	84,691	546,633								546,633
1991	6,242	90,572	7,991	6,993	332,674	105,267	549,739								549,739
1992	7,941	101,495	12,433	6,551	321,883	86,731	537,034								537,034
1993	11,287	123,484	27,045	10,413	374,260	75,966	622,455		5,345	11,228				16,573	639,028
1994		96,757	50	8,389	247,156	71,009	423,361	15,428	23,001	15,332				53,761	477,122
1995		75,736	3	5,268	208,449	89,641	379,097	27,371		22,678				50,049	429,146
1996		76,151	198	2,867	158,525	61,522	299,263	17,226	3,162	12,446				32,834	332,097
1997		48,973	21	2,534	109,762	62,241	223,531	16,798	1,105	8,792				26,695	250,226
1998		37,952	82	1,288	107,574	40,533	187,429	21,057		10,038				31,095	218,524
1999			147	1,709	119,777	31,599	153,232	13,281	83,394	5,466				102,141	255,373
2000			66	2,211	69,643	21,989	93,909	9,775	73,359	4,485	140			87,759	181,668
2001			19	3,795	104,275	21,938	130,027	15,202	51,317	2,222	132			68,873	198,900
2002			8		142,034	36,268	178,310	14,548	71,144	1,530	6,988			94,210	272,520
2003			26		158,849	26,298	185,173	20,810	62,251	1,754	9,135			93,950	279,123
2004			14		131188	45252	176454	27695	48666	1676	10828			88865	265319

Table 6—Commercial Landings (pounds) by Year and State

Totals include fish classified as gray trigger and unclassified triggerfish from Gulf of Mexico waters.

	TX	LA	MS	AL	wFL	eFL	total
1963					7,300		7,300
1964					20,000		20,000
1965					21,700		21,700
1966					13,800		13,800
1967					17,400		17,400
1968					12,500		12,500
1969					22,300		22,300
1970					24,200		24,200
1971					40,400		40,400
1972					62,600		62,600
1973					53,200		53,200
1974					53,100		53,100
1975					78,000		78,000
1976					84,500		84,500
1977					59,386		59,386
1978					58,715		58,715
1979					101,403		101,403
1980					96,423		96,423
1981					89,860		89,860
1982					96,673		96,673
1983				2,670	70,749		73,419
1984		32		14,694	55,435	33	70,194
1985	336	4,766	25	11,840	75,659		92,626
1986	572	14,493	4,008	5,881	70,675		95,629
1987	289	21,941	5,550	3,778	92,045		123,603
1988	1,885	36,980	7,933	7,641	140,623		195,062
1989	429	60,856	7,682	10,389	238,276		317,632
1990	6,908	69,758	9,027	16,613	356,654	78	459,038
1991	6,203	90,572	7,991	6,993	332,674	97	444,530
1992	7,891	101,436	12,433	6,551	321,883		450,195
1993	11,154	128,588	38,273	10,413	370,174	126	558,728
1994	15,391	119,758	15,382	8,389	245,785	14	404,720
1995	27,356	75,736	22,681	5,268	206,836		337,877
1996	17,138	79,313	12,644	2,867	155,283	272	267,516
1997	16,767	50,078	8,813	2,534	106,419	79	184,689
1998	21,037	37,952	10,120	1,288	106,312	15	176,723
1999	13,281	83,394	5,613	1,709	114,906	117	219,020
2000	9,703	73,359	4,551	2,351	68,148	24	158,137
2001	15,202	51,317	2,241	3,927	103,495		176,182
2002	14,548	71,144	1,538	6,988	141,138	206	235,563
2003	20,804	62,251	1,780	9,135	157,840		251,810
2004	27,589	48,666	1,690	10,828	129,697	62	218,533

Table 7—Commercial Landings (pounds) by Year, Gear, and Region

Totals include fish classified as gray trigger and unclassified triggerfish from Gulf of Mexico waters.

	handline+		longline		trap		
	west US Gulf	east US Gulf	west US Gulf	east US Gulf	west US Gulf	east US Gulf	total
1963	4,200	3,100					7,300
1964	4,300	15,700					20,000
1965	4,300	17,400					21,700
1966	5,200	8,600					13,800
1967	5,200	12,200					17,400
1968	3,900	8,600					12,500
1969	7,700	14,600					22,300
1970	8,200	16,000					24,200
1971	9,900	30,500					40,400
1972	15,200	47,400					62,600
1973	13,200	40,000					53,200
1974	13,100	40,000					53,100
1975	16,000	62,000					78,000
1976	14,800	69,700					84,500
1977	9,290	50,096					59,386
1978	10,197	48,518					58,715
1979	31,814	65,670	3,919				101,403
1980	28,707	64,015	2,294	1,406			96,423
1981	20,636	61,465	4,726	3,033			89,860
1982	26,316	55,317	7,398	7,642			96,673
1983	19,350	40,486	4,481	9,102			73,419
1984	29,392	29,099	3,334	8,346	23		70,194
1985	32,230	43,333	5,556	11,507			92,626
1986	14,919	60,397	7,852	12,461			95,629
1987	33,653	65,974	637	23,339			123,603
1988	54,586	124,927	2,498	13,051			195,062
1989	77,330	187,798	9,941	30,166		12,397	317,632
1990	99,018	270,238	279	12,979	54	76,469	459,038
1991	103,179	341,216	32	8		96	444,530
1992	111,628	173,268	368	143,092	79	21,758	450,195
1993	174,339	286,999	452	13,557	2,657	80,723	558,728
1994	152,702	200,702	439	20,207		30,669	404,720
1995	130,156	182,072	509	6,385		18,755	337,877
1996	124,950	112,642	381	6,722		22,821	267,516
1997	75,918	80,972	991	10,456		16,352	184,689
1998	70,479	87,576	92	5,521		13,055	176,723
1999	102,620	93,581	206	9,516		13,097	219,020
2000	94,814	48,132	281	5,467		9,442	158,137
2001	67,669	87,073	49	6,129		15,261	176,182
2002	86,904	128,026	59	3,052		17,522	235,563
2003	85,385	143,688		8,571		14,166	251,810
2004	76,381	114,102	741	14,229		13,080	218,533

Table 9—Bycatch Estimates from Shrimp Fleet

Summary of unexpected levels and ranges for shrimp fleet bycatch estimates for the SEDAR9 species from SEDAR9-DW-26, compared with similar analyses for red snapper, and some supporting statistics.

	Gray Triggerfish	Red Snapper
average CPUE x approx effort	3.8M	27.6M
SEDAR7 model results		
median of annual medians	8.3M	26.3M
range of annual medians	130x	15x
range of annual 95% ci ranges	4.9x-67x	1.7x-29x
Delta model results		
median of annuals	2.2m	13M
range of annual medians	140x	6x
range of annual 95% ci ranges	3.9x-360x	1.4x-6.7x
Model 3 results		
median of annuals	1.7M	14M
range of annual medians	160x	19x
range of annual 95% ci ranges	810x-1300x	190x-270x
frequency of occurrence in C	9%	43%
frequency of occurrence in R	8%	30%
frequency of occurrence in B	0	55%
number of stations		
C	2863	9943
R	26983	26486
B	402	8130

C refers to observer data for commercial shrimp tows without BRDs
B refers to observer data for commercial shrimp tows with BRDs
R refers to research vessel (Oregon II) tows

Table 10—Standardized Fishery Dependent Indices

Preliminary results from a generalized linear modeling (GLM) standardization procedure, applied to each of three fishery dependent data series: Marine Recreational Fisheries Statistics Survey (MRFSS), headboat surveys (HB), and commercial handline logbook records (CmHL).

YEAR	MRFSS		HB		CmHL	
	ln(CPUE)	SE	ln(CPUE)	SE	ln(CPUE)	SE
1981	-0.73841	0.664575				
1982	-0.13741	0.791705				
1983	-0.75398	0.701211				
1984	-1.00749	1.129571				
1985	-1.28787	0.7645				
1986	0.095956	0.228956	0.358655	0.237242		
1987	-0.3655	0.271743	0.435488	0.236496		
1988	0.173357	0.328415	0.634518	0.234249		
1989	0.791917	0.523376	0.892188	0.230057		
1990	0.846615	0.49101	1.001365	0.21588		
1991	0.274018	0.297221	1.072999	0.216655		
1992	0.61553	0.223591	1.217308	0.214983		
1993	0.035172	0.240358	0.921846	0.21026	0.066111	0.131782
1994	-0.02243	0.273638	0.758721	0.208563	0.306531	0.119644
1995	-0.02395	0.325085	0.557595	0.213566	0.561	0.142356
1996	-0.40134	0.275559	0.458898	0.217863	0.311129	0.108223
1997	-0.30689	0.212177	0.370537	0.221584	0.247547	0.104575
1998	-0.59082	0.169536	0.349206	0.218645	0.137542	0.104335
1999	-0.29001	0.134901	0.346791	0.226467	0.261546	0.095402
2000	-0.54454	0.138038	0.225678	0.231349	0.124708	0.105021
2001	-0.22646	0.150328	0.125933	0.229549	0.244972	0.103453
2002	-0.32847	0.137688	0.192833	0.245457	0.432149	0.097882
2003	-0.44001	0.136298	0.348264	0.245239	0.61988	0.097557
2004	-0.09139	0.124442			0.506137	0.101281

Table 11—Standardized Fishery Independent Indices

Preliminary results from analyses of various Southeast Area Monitoring and Assessment Program (SEAMAP) surveys, including fall and summer trawl surveys and video surveys.

YEAR	Fall Trawl	Summer Trawl	Video
	Median CPUE	Median CPUE	Frequency Occurrence
1972	4.478		
1973	2.838		
1974	2.128		
1975	0.9269		
1976	0.4308		
1977	4.49		
1978	1.348		
1979	1.326		
1980	3.888		
1981	2.628	0.1286	
1982	4.18	0.634	
1983	2.086	0.5065	
1984	1.75	0.3237	
1985	1.855	0.2881	
1986	2.119	0.4816	
1987	2.212	0.5751	
1988	1.902	0.2917	
1989	3.379	0.6378	
1990	0.7793	0.9617	
1991	12.91	1.377	
1992	0.7577	0.5725	0.68549
1993	6.407	0.3844	0.37395
1994	6.133	1.48	0.33632
1995	2.572	1.099	0.31823
1996	2.263	0.3611	0.29654
1997	1.545	0.8732	0.62533
1998	0.1468	0.2662	
1999	3.463	2.321	
2000	6.024	3.764	
2001	11.14	4.151	
2002	2.58	1.111	0.29957
2003	2.188	0.3406	
2004	2.616	0.3721	

Table 12. Available recreational landings in numbers (Type A + B1).

Recreational Year	Headboat Gulf	East	West	MRFSS Gulf	East	West	Texas DFW
1981				345898	307135	38763	
1982				892388	834149	58239	
1983				357551	159396	198156	27889
1984				120098	53267	66831	36599
1985				120334	104775	15559	7237
1986	45042	29024	16018	327963	316590	11373	4425
1987	38730	22033	16697	443284	438551	4732	6522
1988	68565	27125	41440	679382	669026	10356	14058
1989	80522	55630	24892	776593	727140	49453	32744
1990	131381	105816	25565	1057504	961088	96416	9190
1991	89259	58121	31138	756265	658143	98121	8930
1992	110677	68925	41752	609676	572261	37415	72429
1993	102971	58787	44184	545558	528962	16596	39204
1994	110185	53468	56717	498669	458115	40555	6302
1995	97666	45825	51841	567541	502196	65345	4439
1996	76526	36195	40331	259844	254894	4950	2317
1997	63685	34458	29227	272134	257813	14321	4965
1998	53188	37085	16103	232073	225889	6184	4852
1999	40981	34143	6838	211015	178960	32055	2973
2000	32223	26245	5978	180783	128213	52570	6741
2001	40057	32563	7494	216954	198300	18654	4460
2002	53854	44858	8996	298349	292474	5876	2767
2003	63483	46468	17015	366181	353300	12880	1885
2004	56216	43101	13115	432002	403068	28934	

Table 13. MRFSS landings in numbers by state (Type A + B1)

Year	AL	FL	LA	MS	TX
1981	19562	287573	27197		11566
1982	42019	791901	53685	229	4554
1983	10405	148991	198156		
1984	355	52912	35198	0	31633
1985		104775	10785		4774
1986	24226	292364	11373		
1987	21248	415858	4732	1446	
1988	95308	572660	10356	1058	
1989	165717	558956	49453	2467	
1990	597233	354460	96416	9395	
1991	152593	504151	98121	1399	
1992	177880	390688	37415	3692	
1993	177417	349715	16596	1830	
1994	86137	367505	40555	4473	
1995	217284	276246	65345	8666	
1996	126955	122138	4950	5800	
1997	96917	158213	14321	2683	
1998	64765	152620	6184	8505	
1999	51916	126197	32055	847	
2000	42455	85254	52570	504	
2001	62384	135559	18654	356	
2002	107235	183227	5876	2012	
2003	92958	259561	12880	781	
2004	129301	260953	28934	12815	

Table 14. Headboat landings in numbers by state.

Year	Texas	Louisiana	Alabama and Florida
1986	15611	407	29024
1987	16085	612	22033
1988	39513	1927	27125
1989	23537	1355	55630
1990	21650	3915	105816
1991	24110	7028	58121
1992	35890	5862	68925
1993	38226	5958	58787
1994	50039	6678	53468
1995	47925	3916	45825
1996	37503	2828	36195
1997	28731	496	34458
1998	15222	881	37085
1999	5854	984	34143
2000	5721	257	26245
2001	7315	179	32563
2002	8817	179	44858
2003	12782	4233	46468
2004	13115	5750	41906

Table 15. Texas DPW recreational landings in numbers by year and mode.

Year	Headboat Landings (# fish)	Charter Landings (# fish)	Private Landings (# fish)
1983	23897	152	3840
1984	33679		2920
1985		80	7157
1986	31		4394
1987		1388	5134
1988	58	203	13797
1989	53	102	32589
1990	112	315	8763
1991		137	8793
1992		1870	70559
1993			39204
1994		30	6272
1995			4439
1996		26	2291
1997		815	4150
1998		559	4293
1999		510	2463
2000			6741
2001		792	3668
2002		307	2460
2003		449	1436

9 Figures

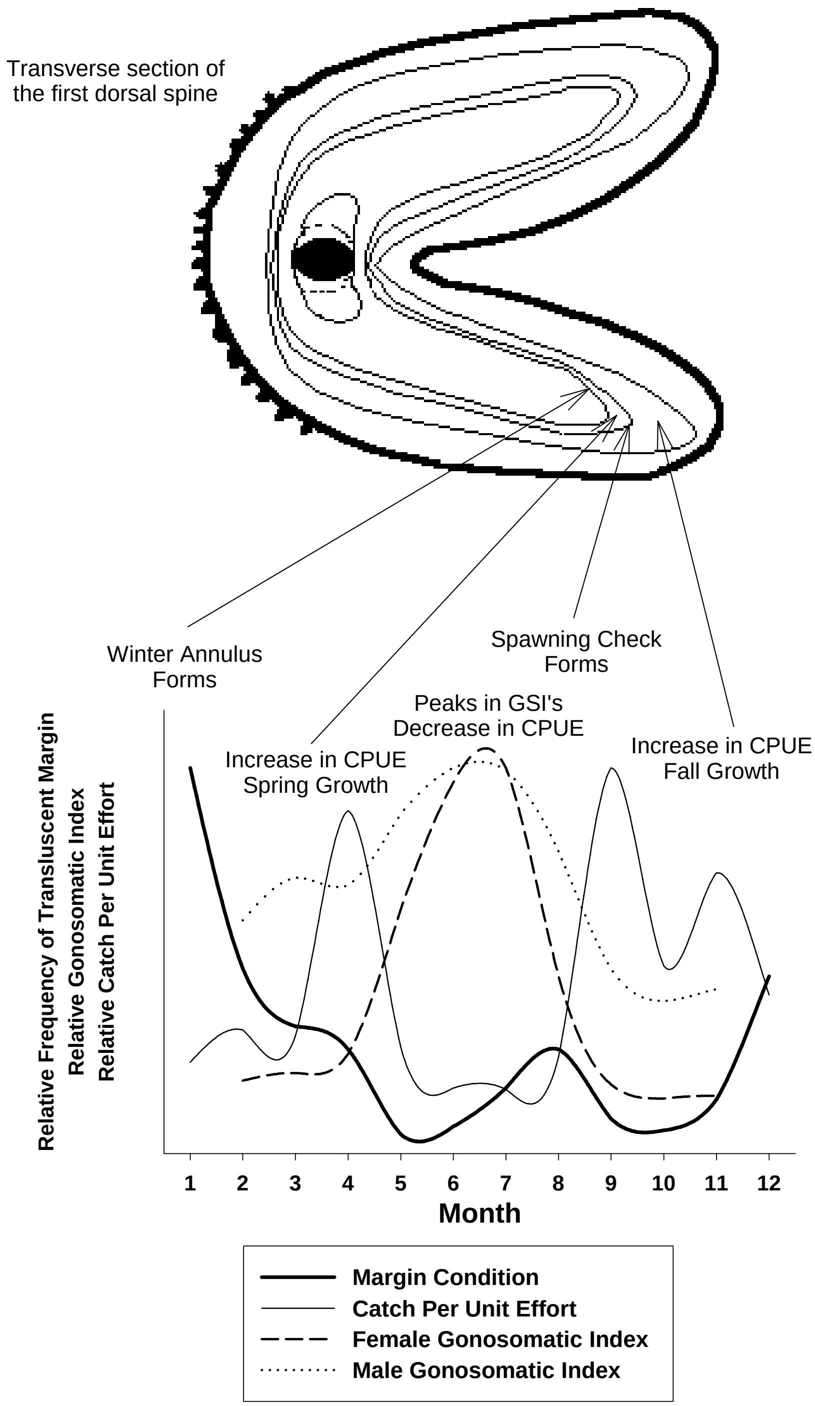

Figure 1. Annulus formation in the first dorsal spine of gray triggerfish.

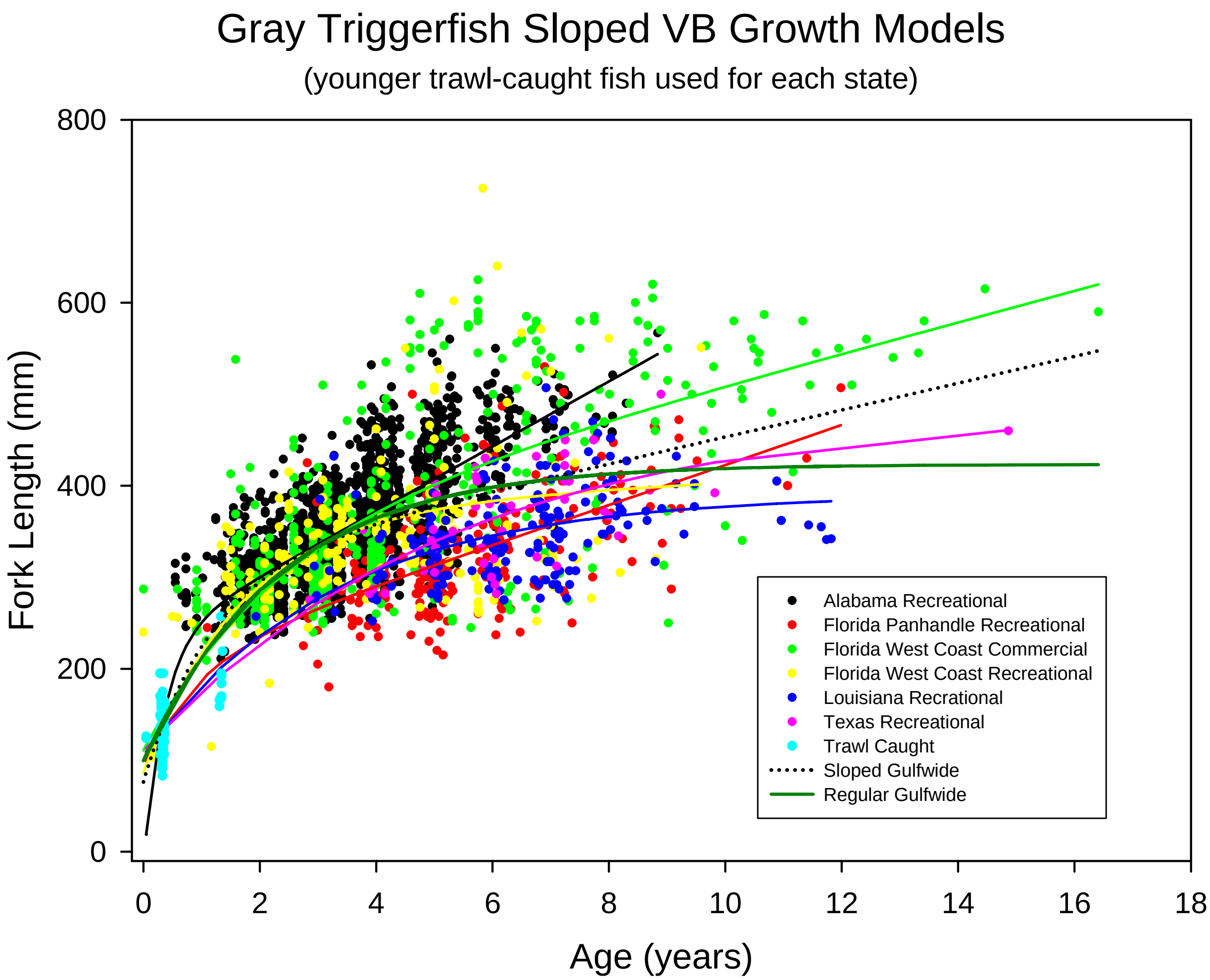

Figure 2. Regular and sloped von Bertalanffy models of Gulf of Mexico gray triggerfish.

- Alabama Recreational: $FL_{age}=229.6+(35.5536age)(1-e^{-2.9344(age-0.0179)})$
- Florida Panhandle Recreational: $FL_{age}=203.9+(21.8820age)(1-e^{-1.1739(age+0.5177)})$
- Florida West Coast Commercial: $FL_{age}=339.4+(17.0939age)(1-e^{-0.4966(age+0.7957)})$
- Florida West Coast Recreational: $FL_{age}=373.3+(3.0551age)(1-e^{-0.5968(age+0.4418)})$
- Louisiana Recreational: $FL_{age}=390.6(1-e^{-0.3071(age+1.0193)})$
- Texas Recreational: $FL_{age}=482.4(1-e^{-0.1913(age+1.3446)})$
- Sloped Gulfwide: $FL_{age}=306.4+(14.6865age)(1-e^{-0.9099\,(age+0.3142)})$
- Regular Gulfwide: $FL_{age}=423.4\,(1-e^{-0.4269\,(age+0.6292)})$

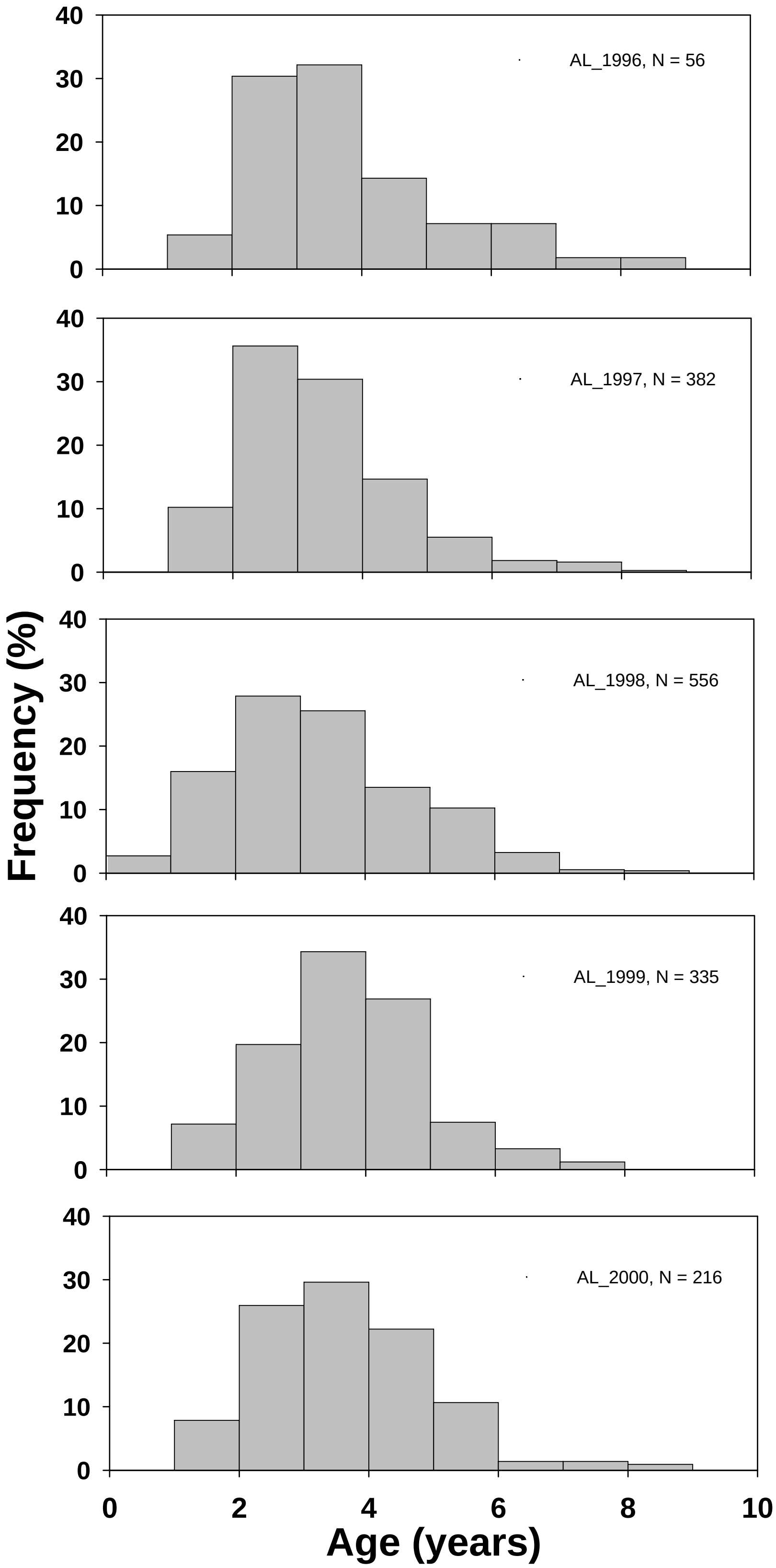

Figure 3. Age frequency histograms of gray triggerfish collected off Alabama.

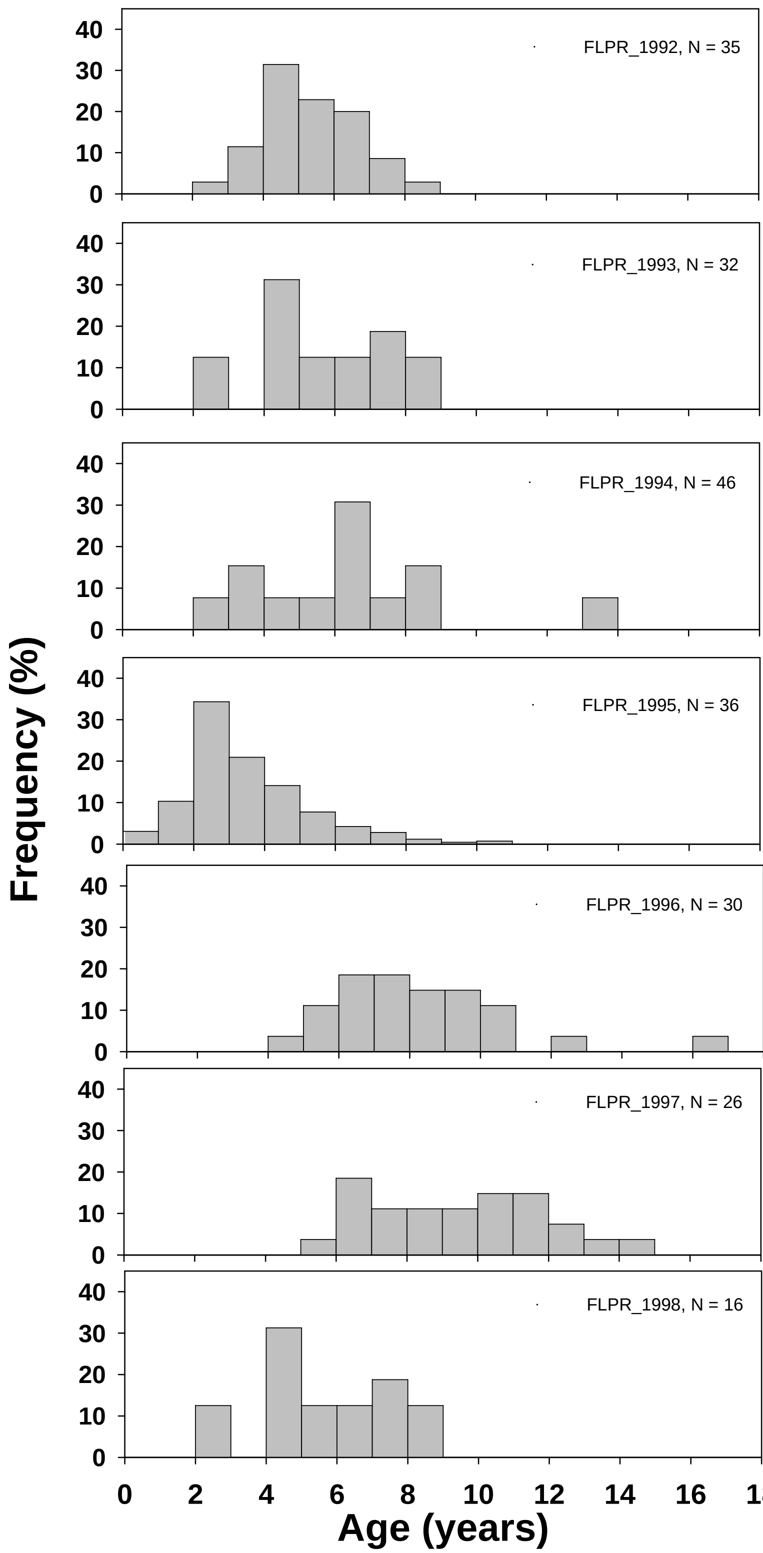

Figure 4. Age frequency histograms of gray triggerfish collected from Florida panhandle recreational fishery (1992 - 1998).

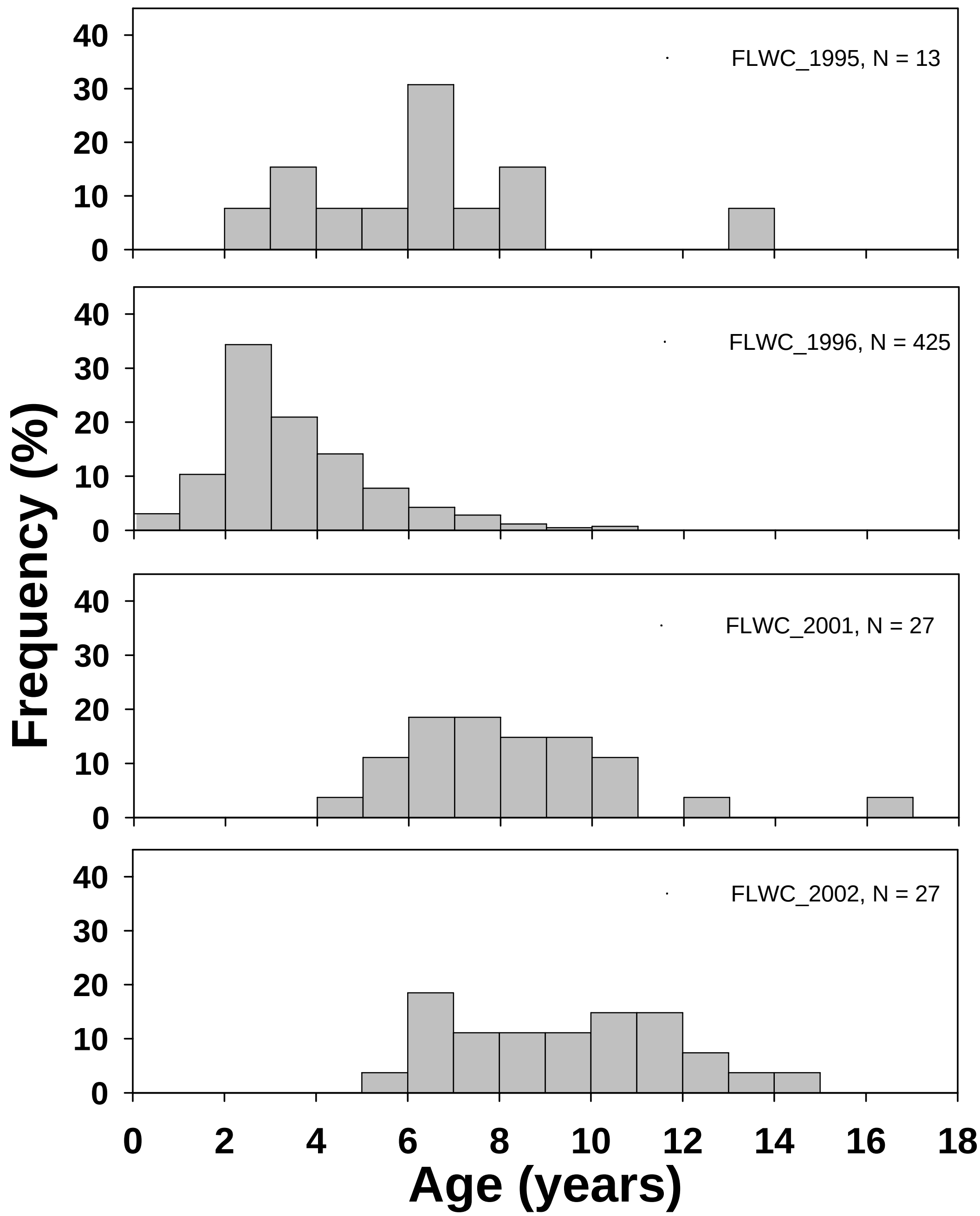

Figure 5. Age frequency histograms of gray triggerfish collected from Florida west coast commercial fishery (1995, 1996, 2001, and 2002).

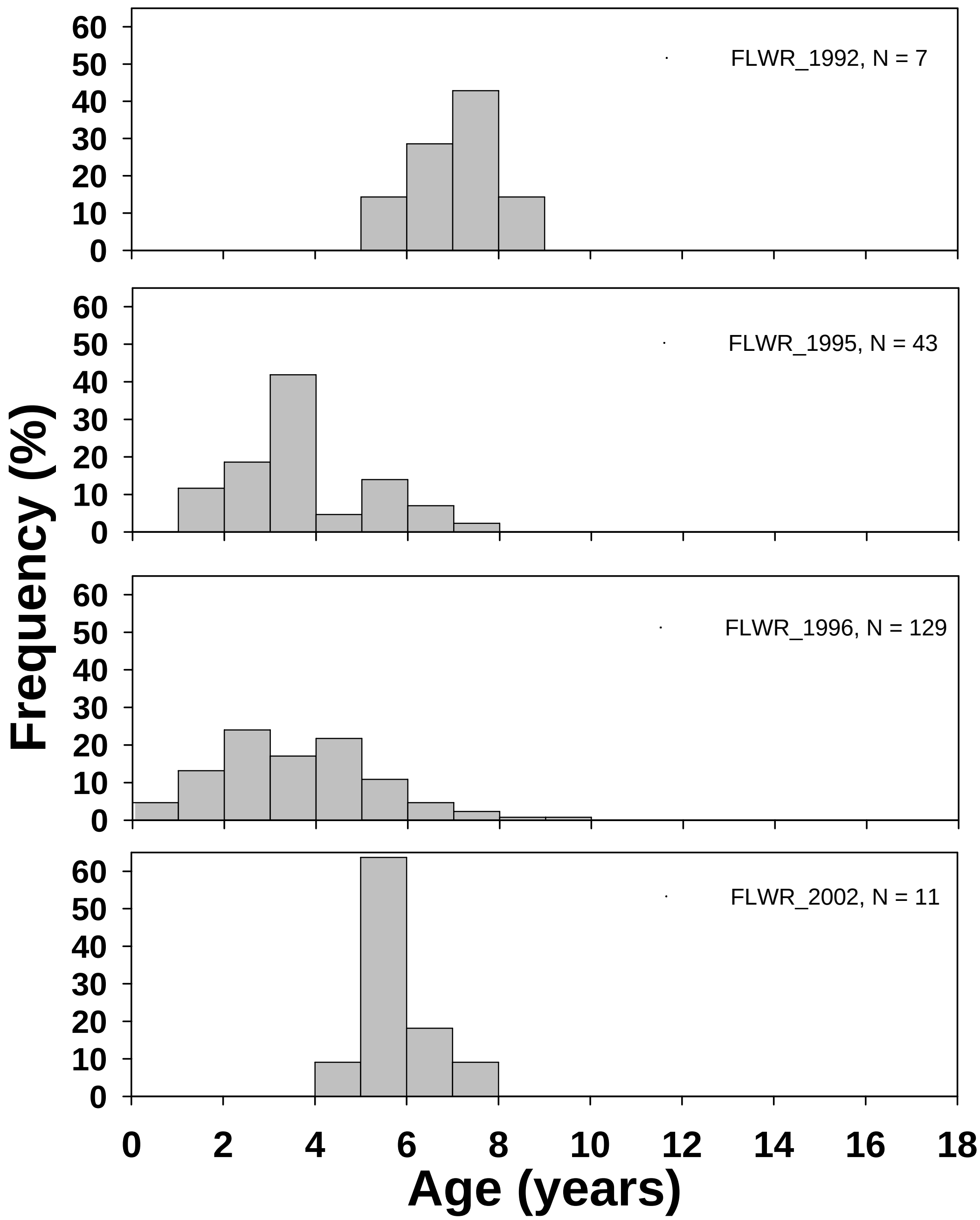

Figure 6. Age frequency histograms of gray triggerfish collected from Florida west coast recreational fishery (1992, 1995, 1996, and 2002).

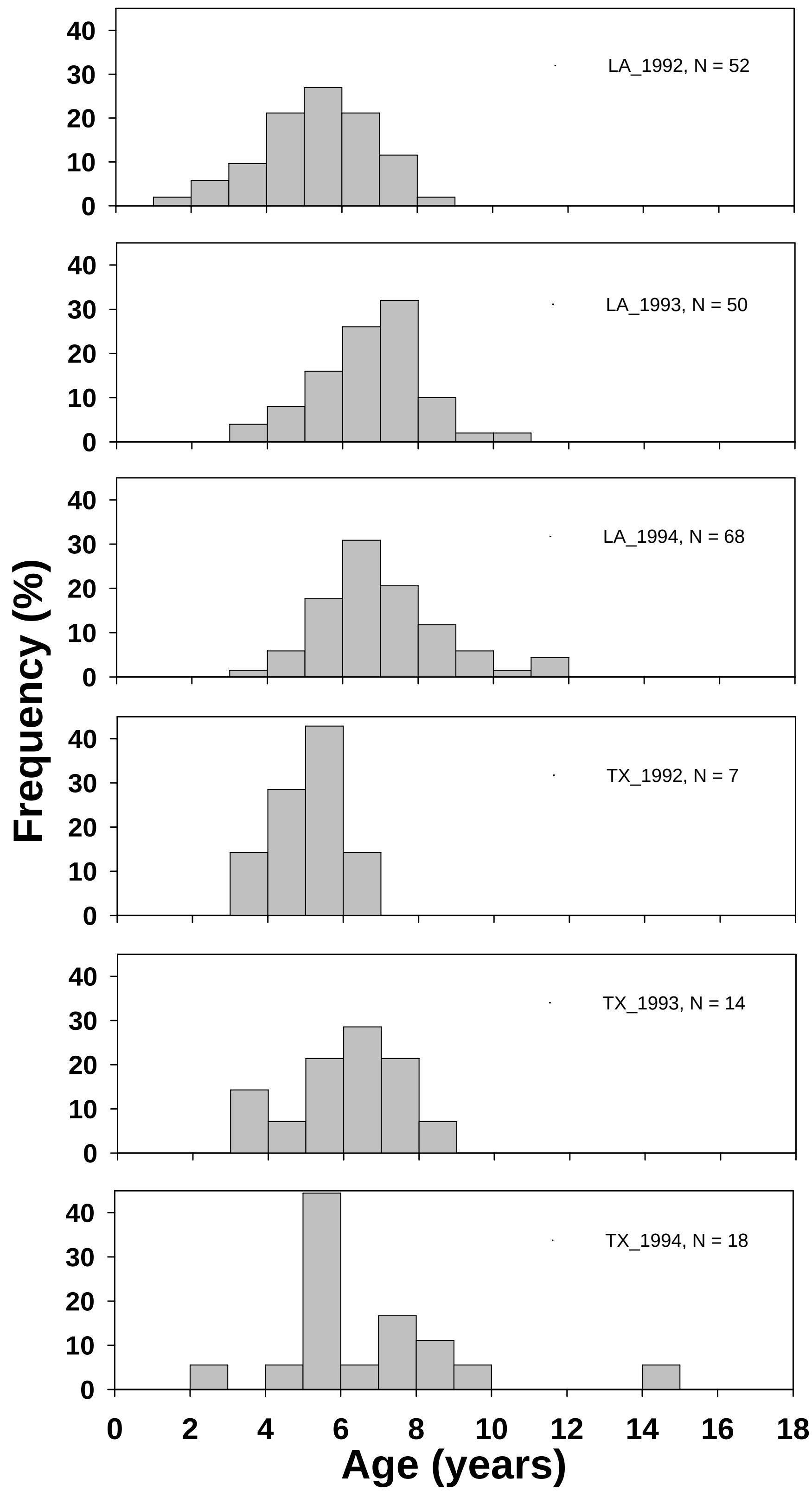

Figure 7. Age frequency histograms of gray triggerfish collected off Louisiana and Texas (1992 - 1994).

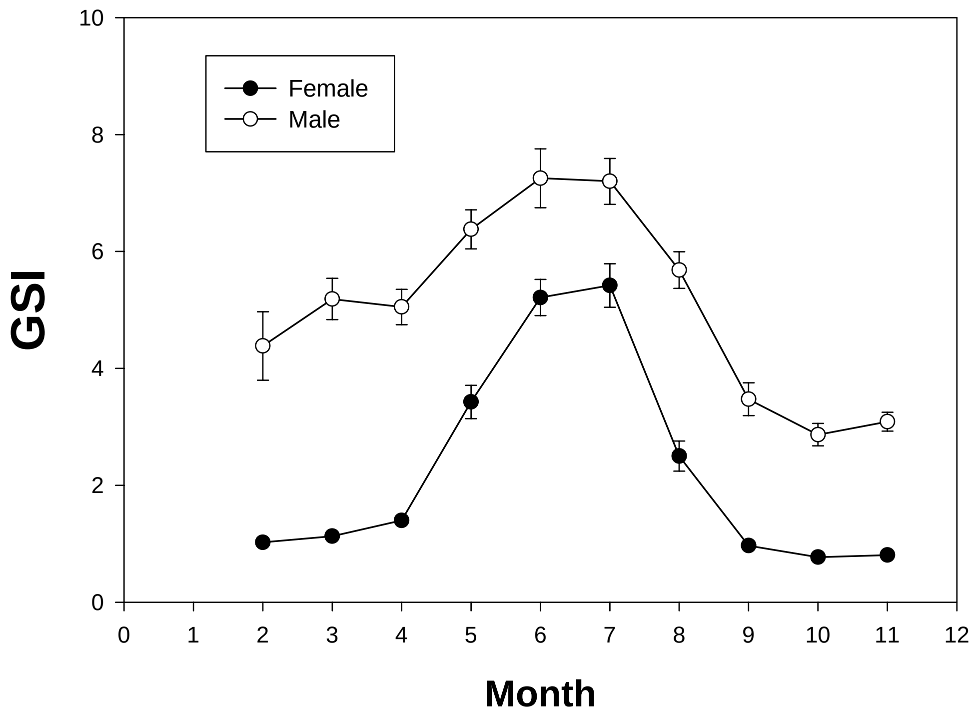

Figure 8. Mean monthly gonosomatic indices for male [100*(gonad weight as % body weight)] and female (gonad weight as % body weight) gray triggerfish. Error bars represent standard error and numbers represent monthly sample sizes.

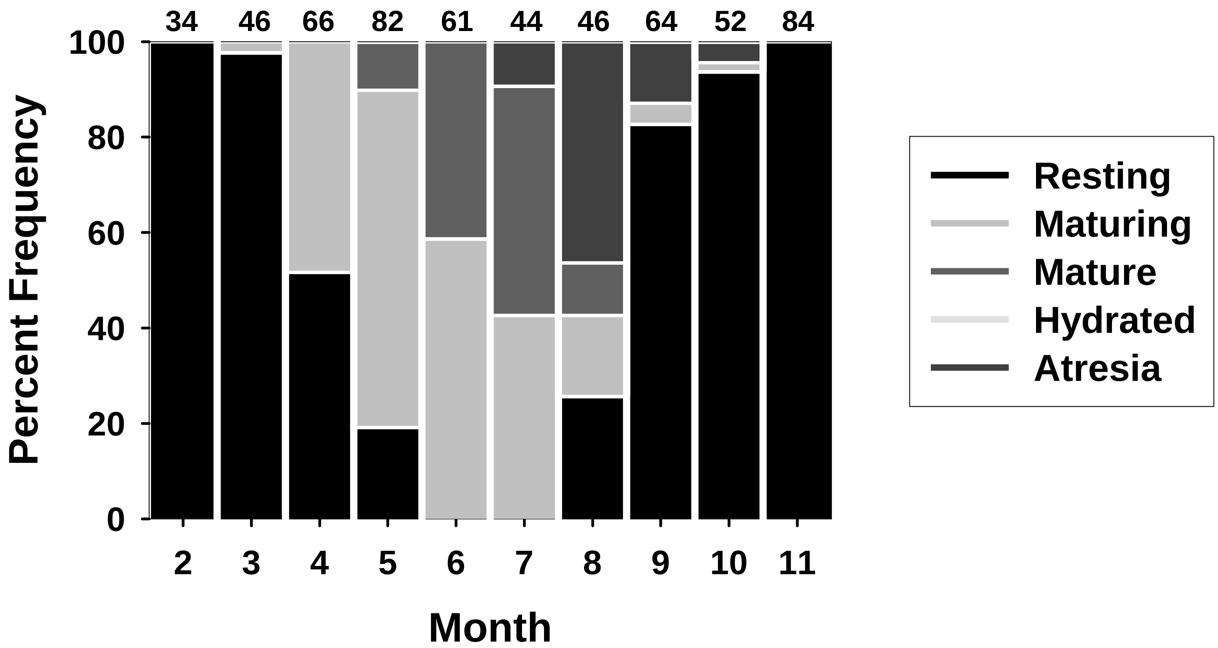

Figure 9. Monthly histological condition of female gray triggerfish gonads. Numbers on the upper axis represent monthly sample sizes.

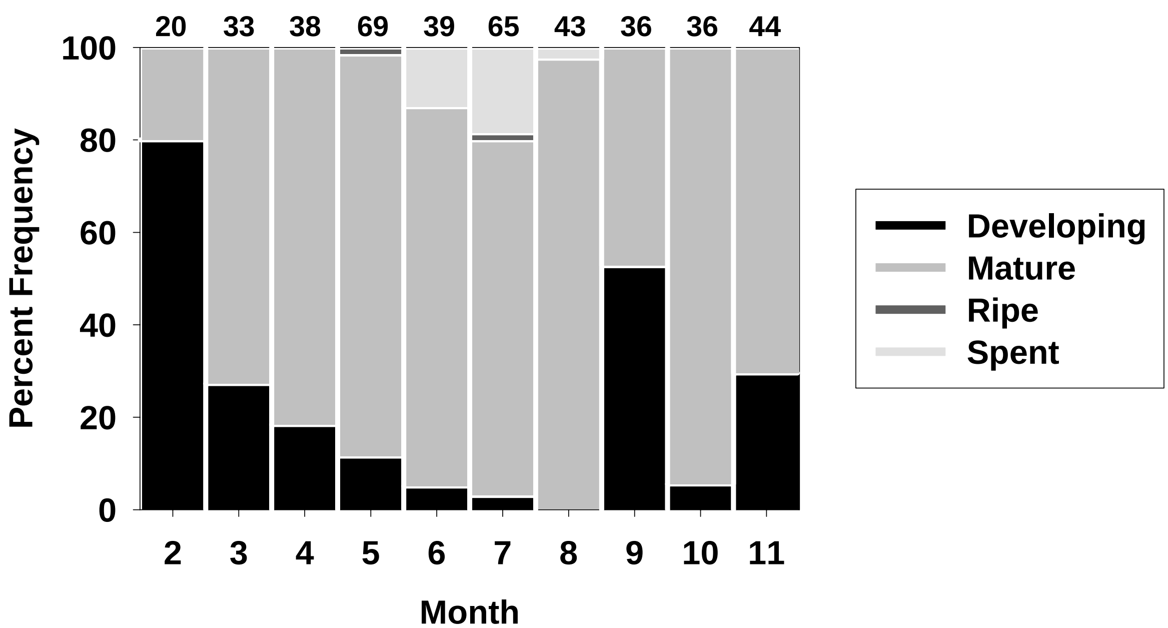

Figure 10. Monthly histological condition of male gray triggerfish gonads. Numbers on upper axis represent monthly sample sizes.

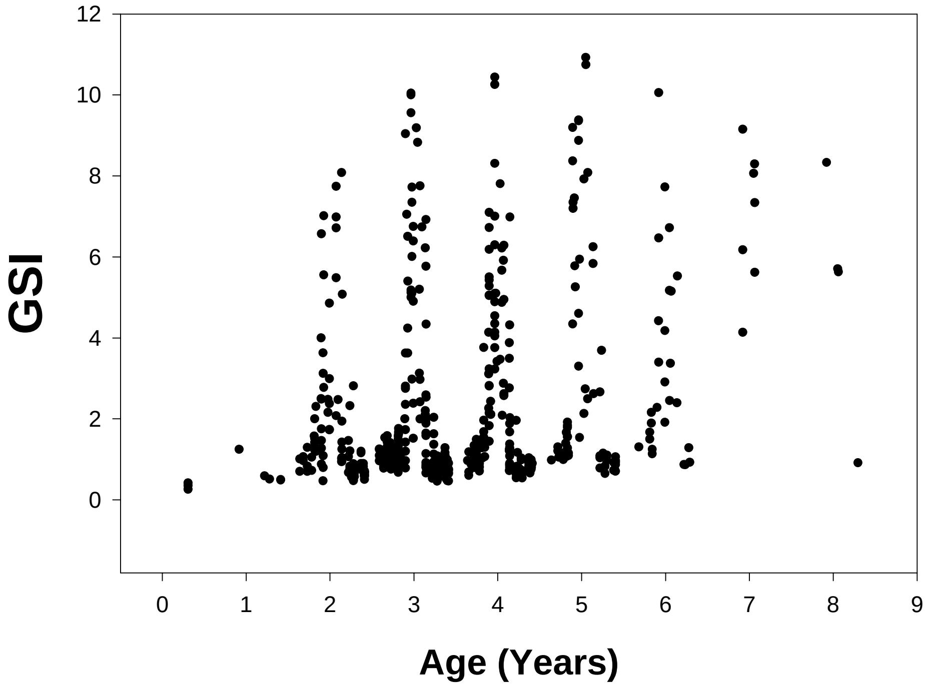

Figure 11. Gonosomatic index (gonad weight as % body weight) versus age of female gray triggerfish.

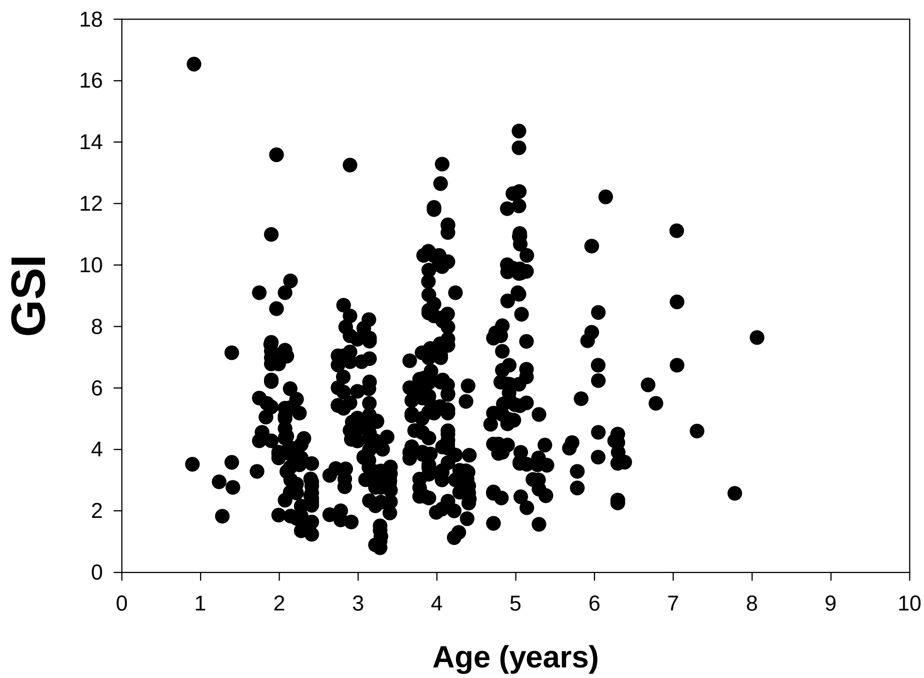

Figure 12. Gonosomatic index [100*(gonad weight as % body weight)] versus age of male gray triggerifsh.

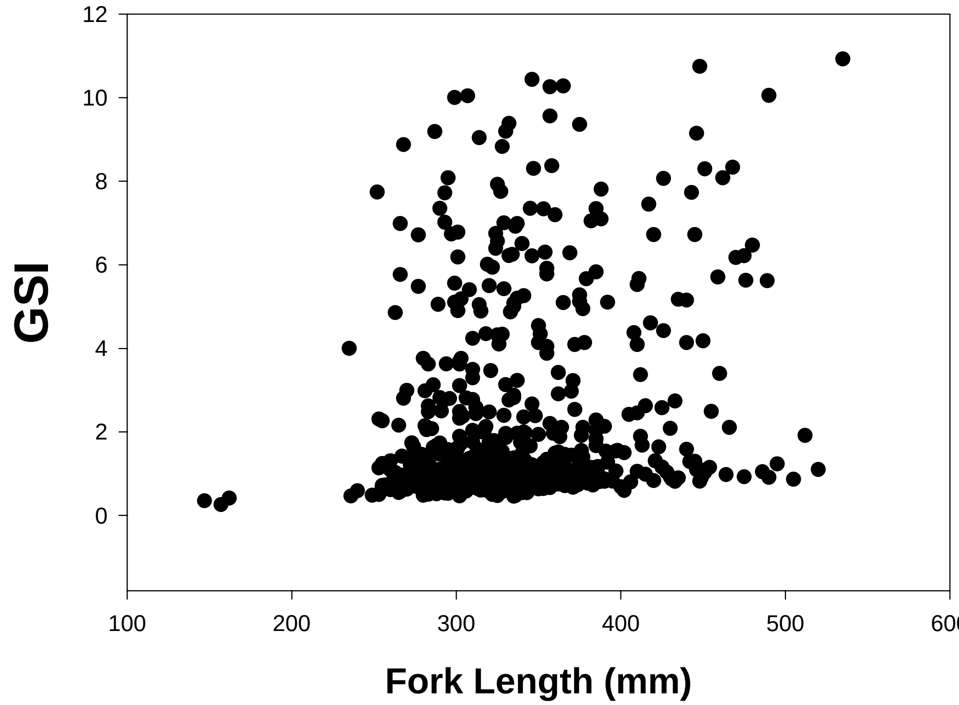

Figure 13. Gonosomatic index (gonad weight as % body weight) versus fork length of female gray triggerfish.

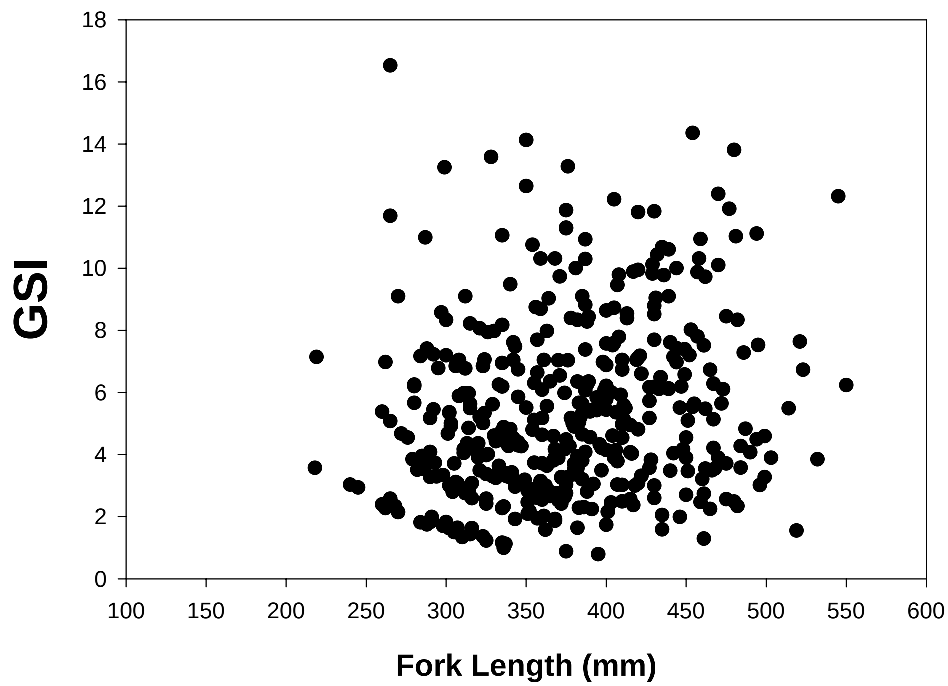

Figure 14. Gonosomatic index [100*(gonad weight as percent body weight)] versus fork length of male gray triggerfish.

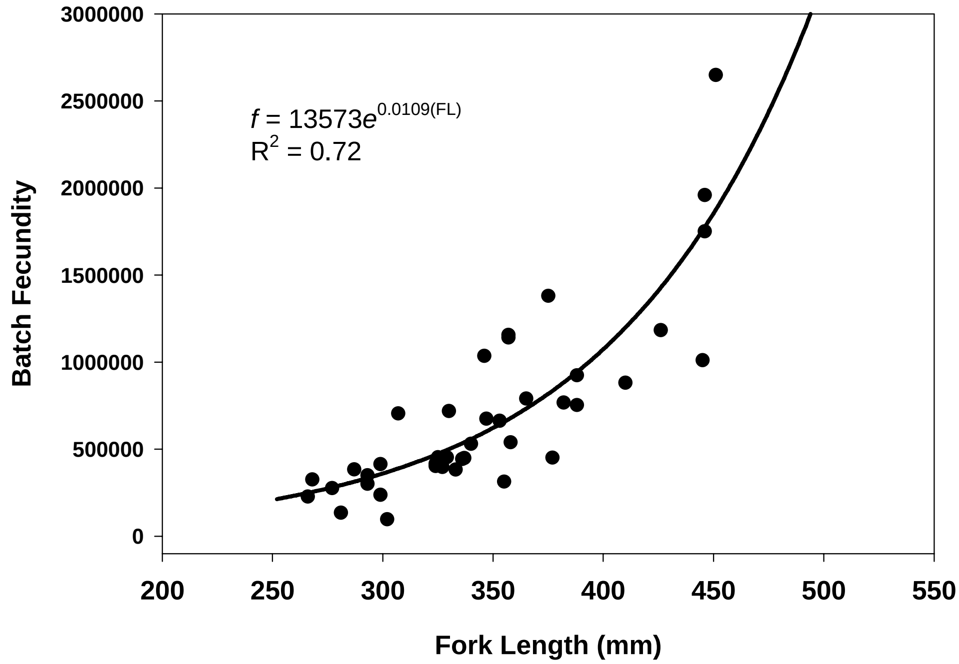

Figure 15. Batch fecundity versus fork length of gray triggerfish.

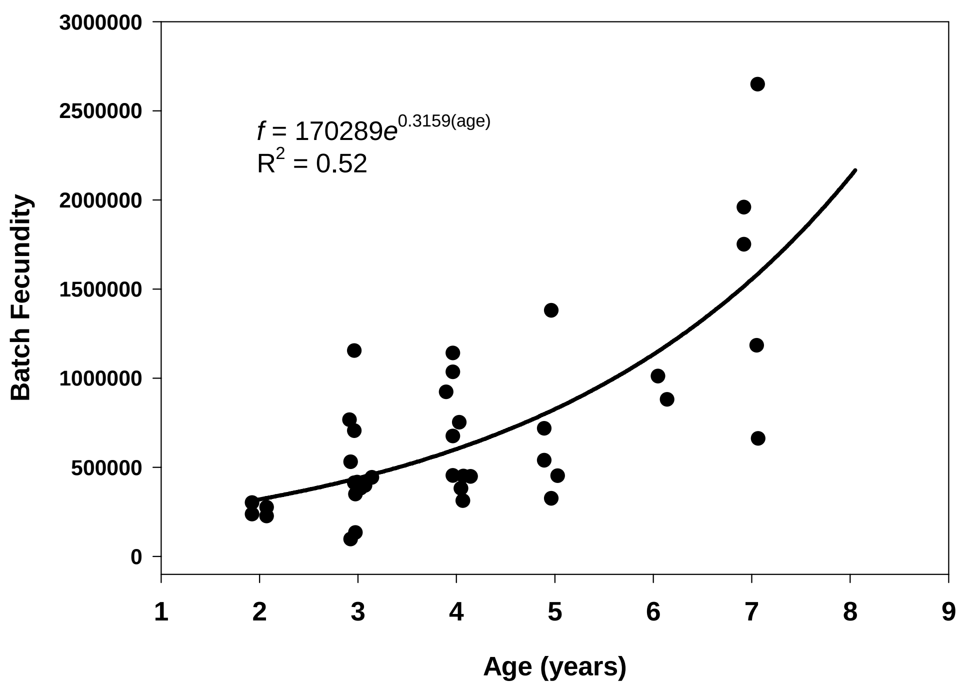

Figure 16. Batch fecundity versus age of gray triggerfish.

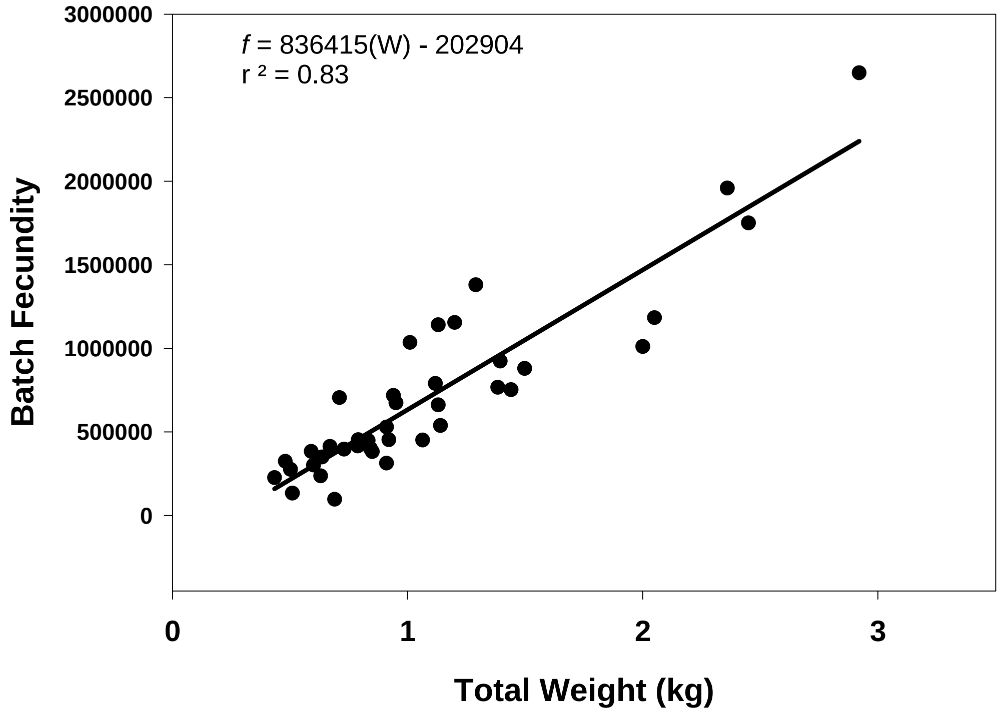

Figure 17. Batch fecundity versus total weight of gray triggerfish.

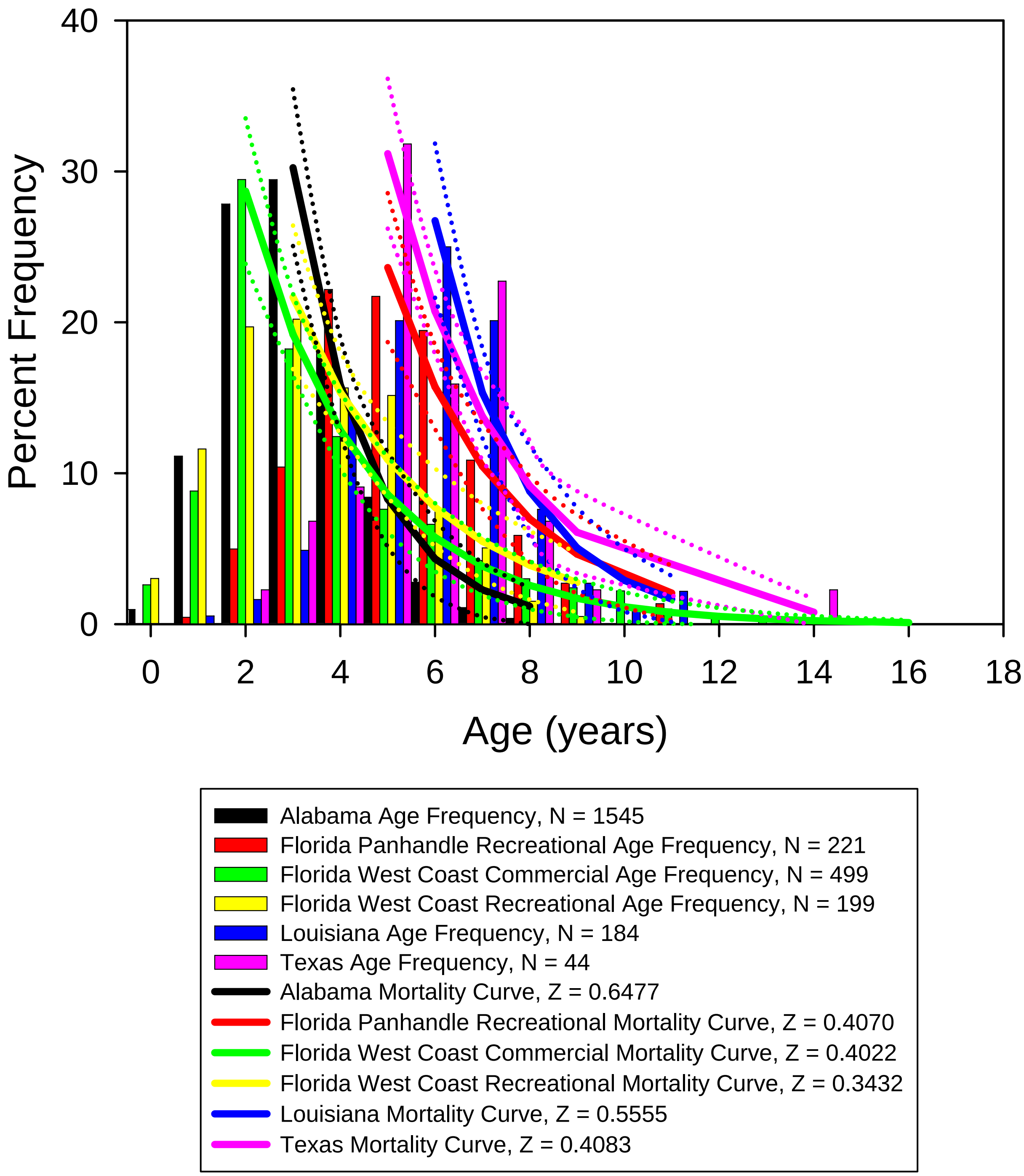

Figure 18. Age frequency histograms and total instantaneous mortality estimates by state (95 % confidence intervals shown).

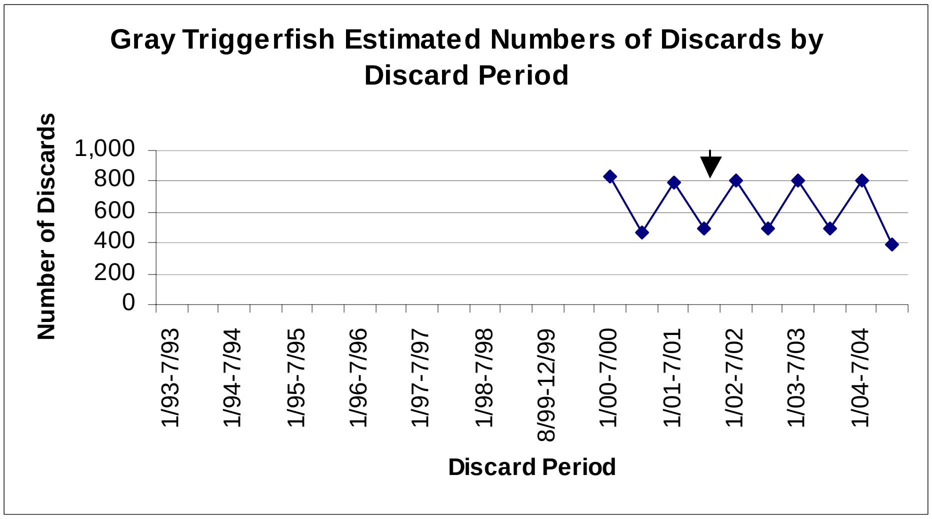

Figure 19—Estimated Numbers of Commercial Discards over Time

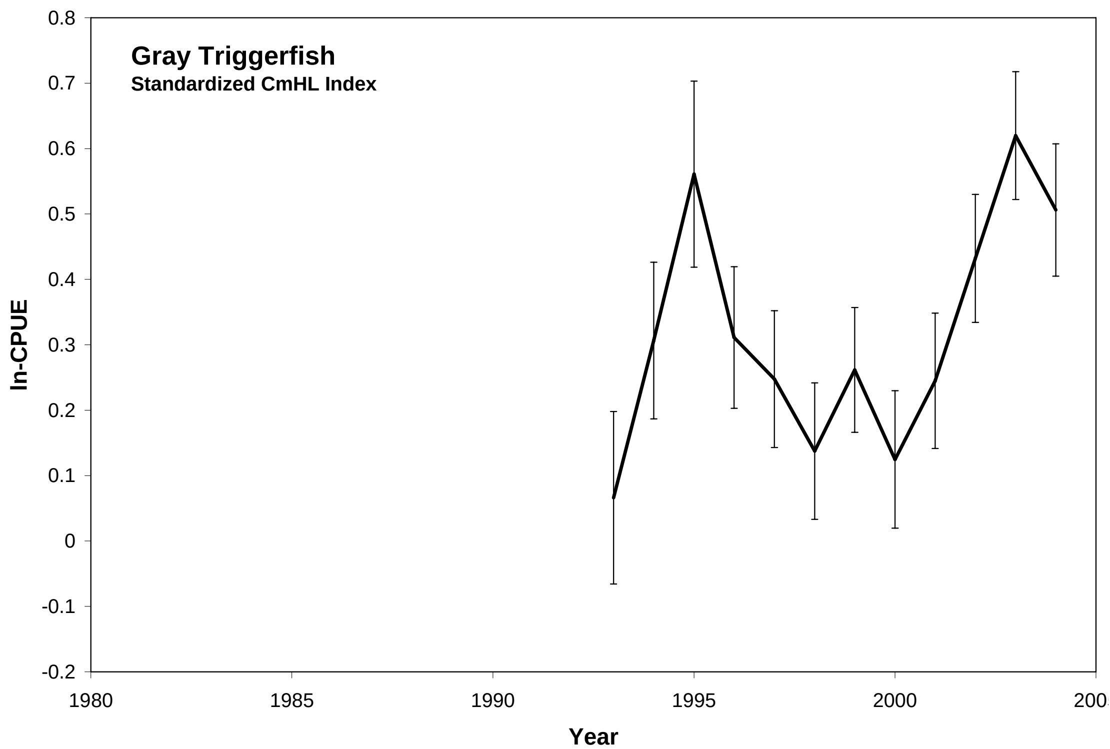

Figure 20—Standardized Commercial Handline Logbook Index
Generalized linear model (GLM) used to standardize observation. Error bars represent standard errors.

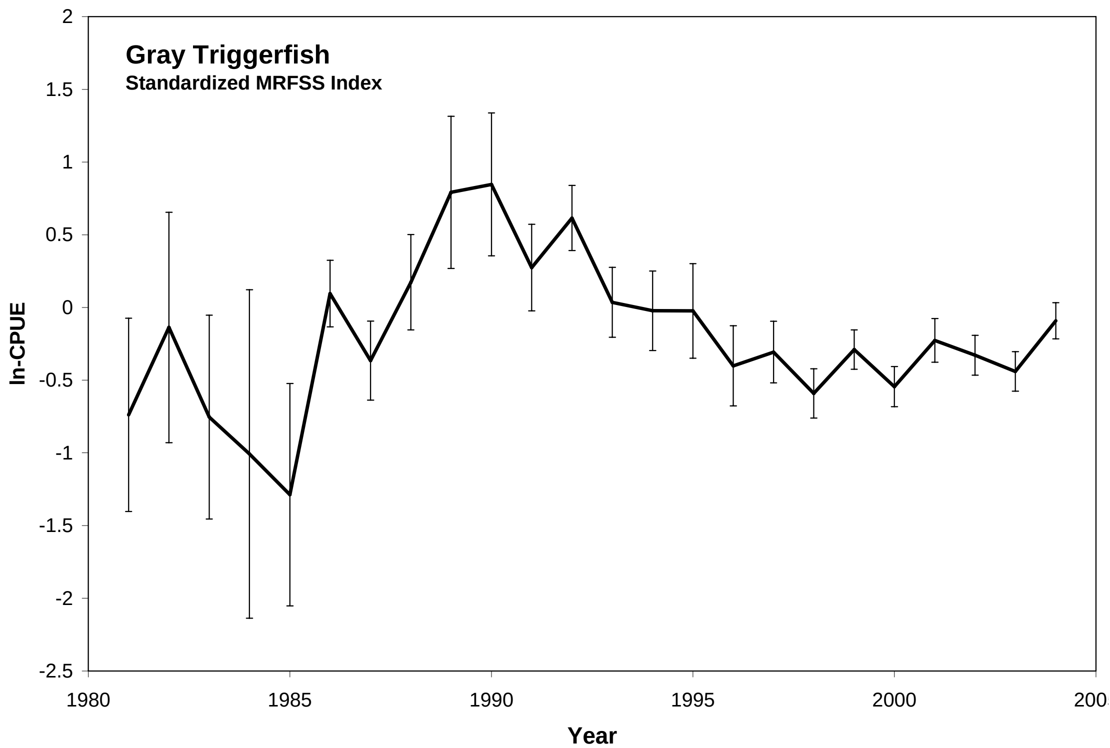

Figure 21—Standardized MRFSS Index

GLM used to standardize observation. Error bars represent standard errors.

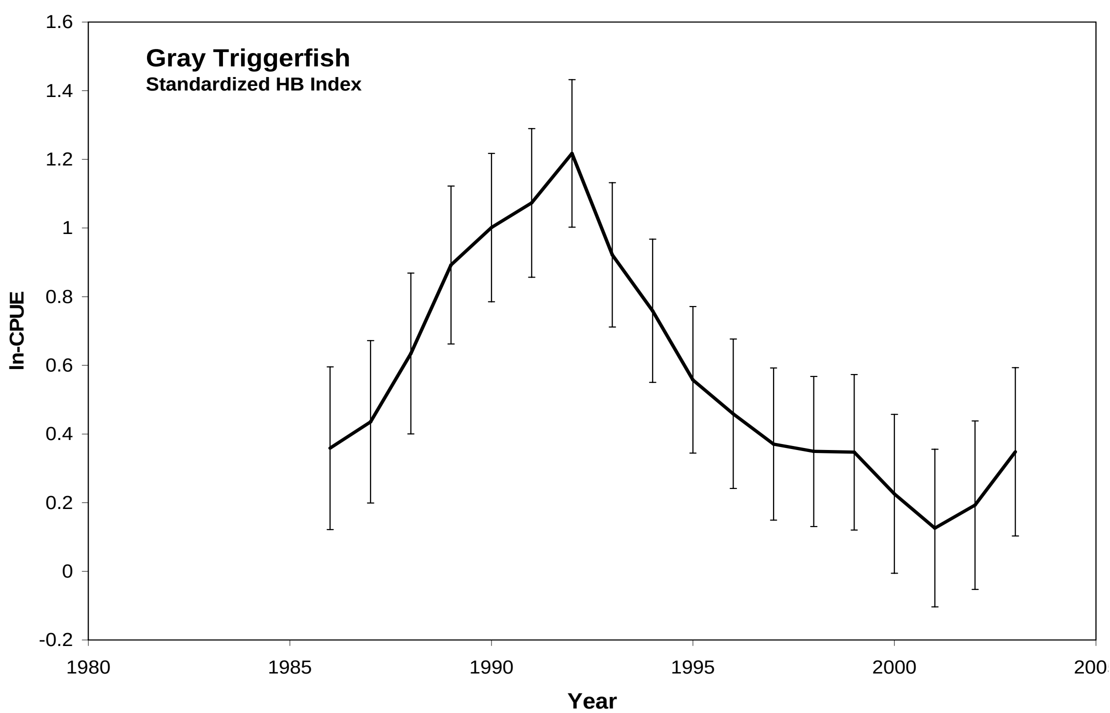

Figure 22—Standardized Headboat Index
GLM used to standardize observation. Error bars represent standard errors.

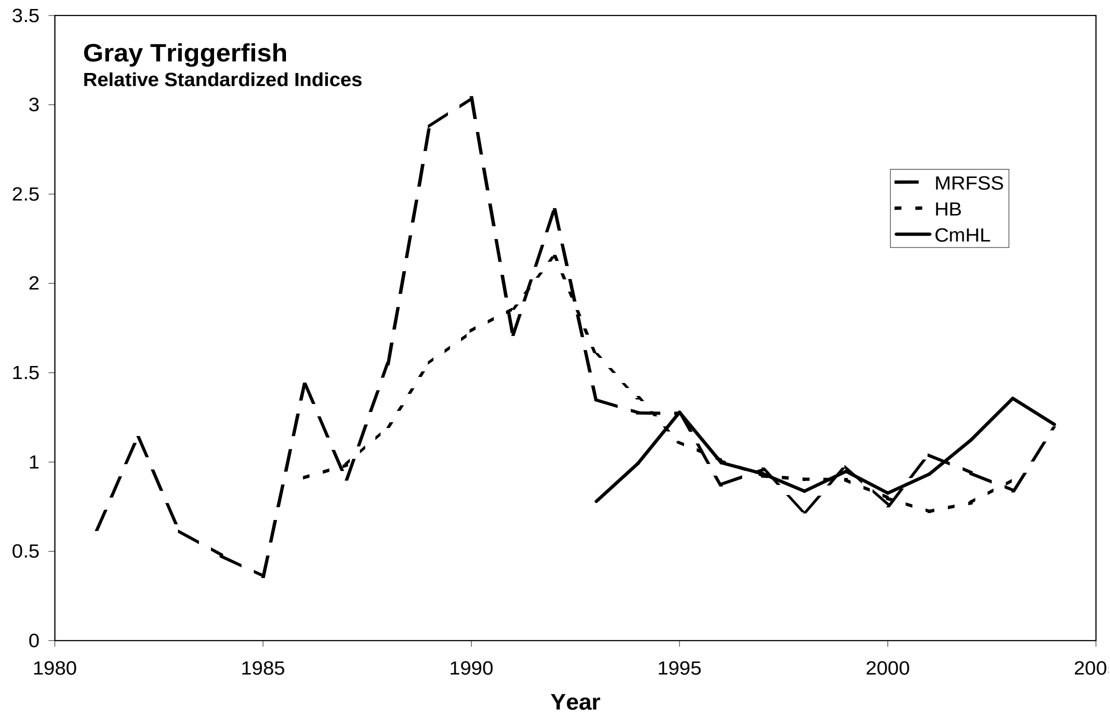

Figure 23—Relative Standardized Fishery Dependent Indices
Normalized to share an average value of 1 from the period of complete overlap, 1993-2003

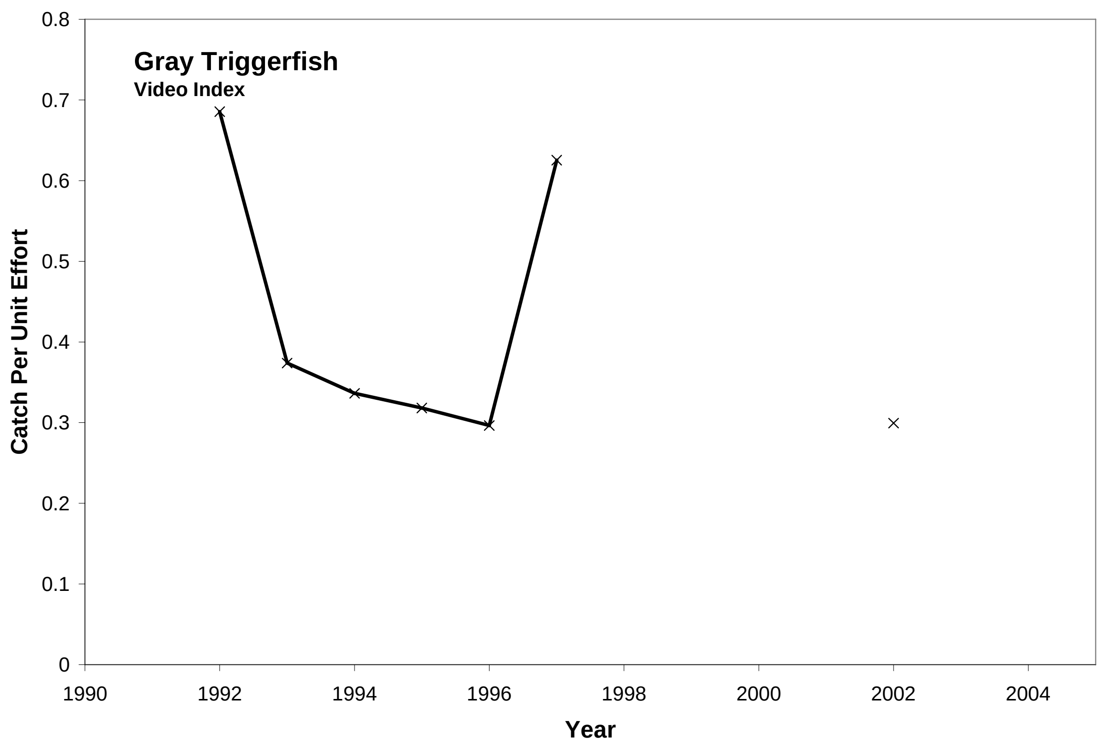

Figure 24—Survey-Derived SEAMAP Video Survey Index

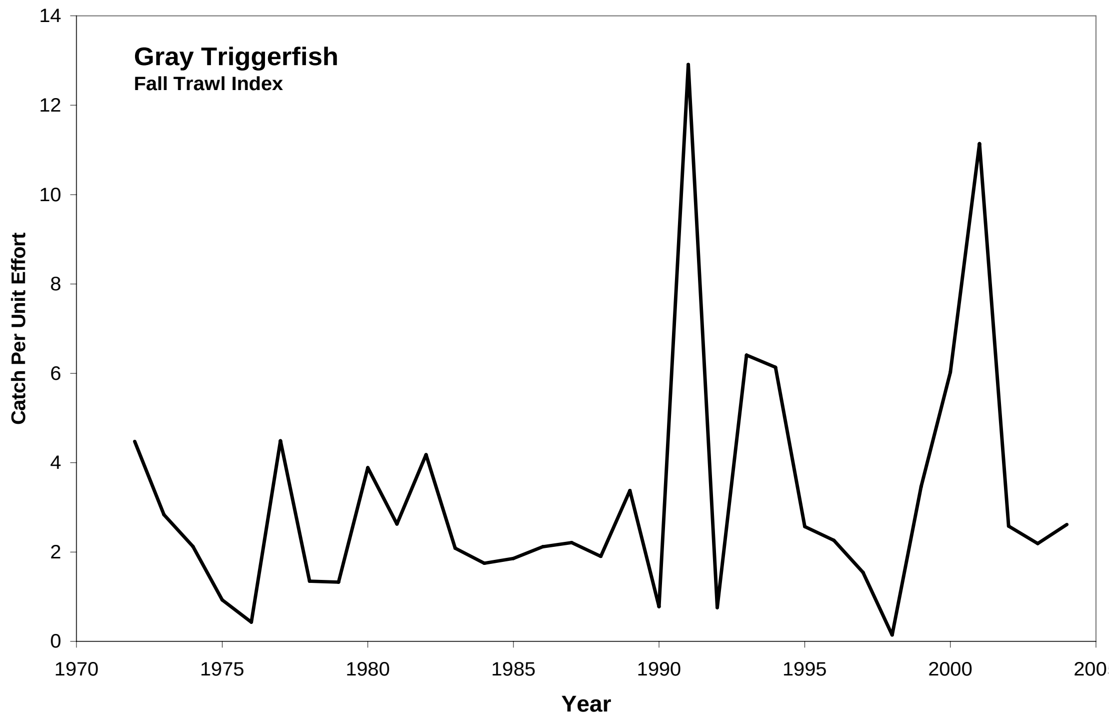

Figure 25—Bayesian Fall SEAMAP Trawl Survey Index

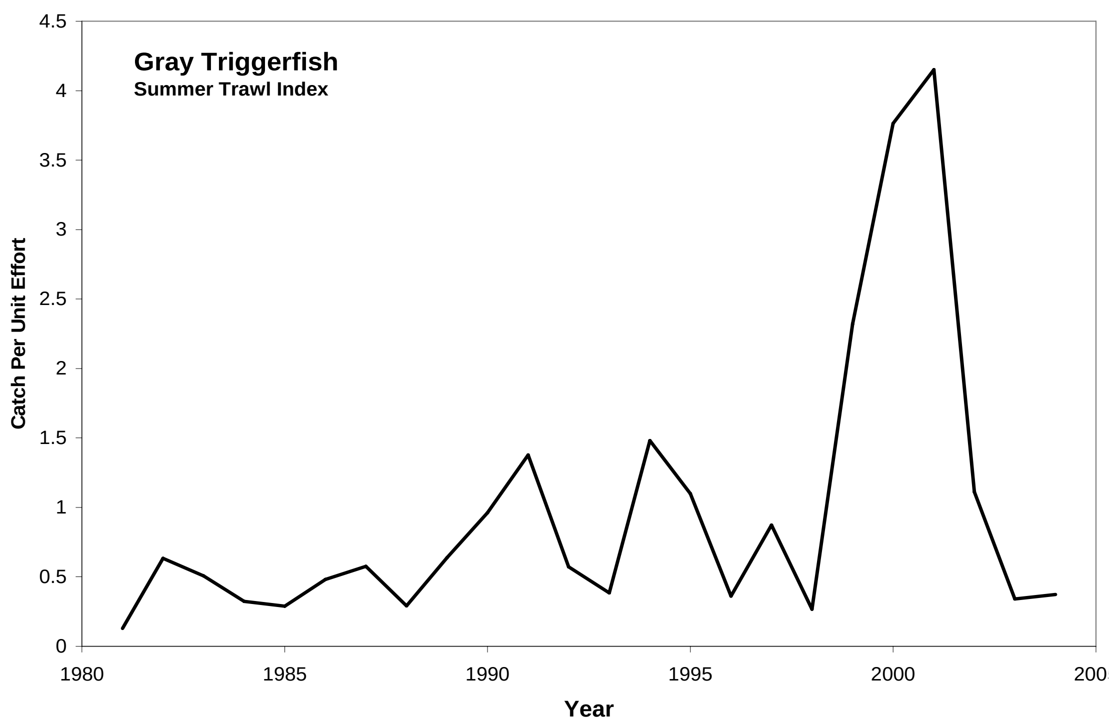

Figure 26—Bayesian Summer SEAMAP Trawl Survey Index

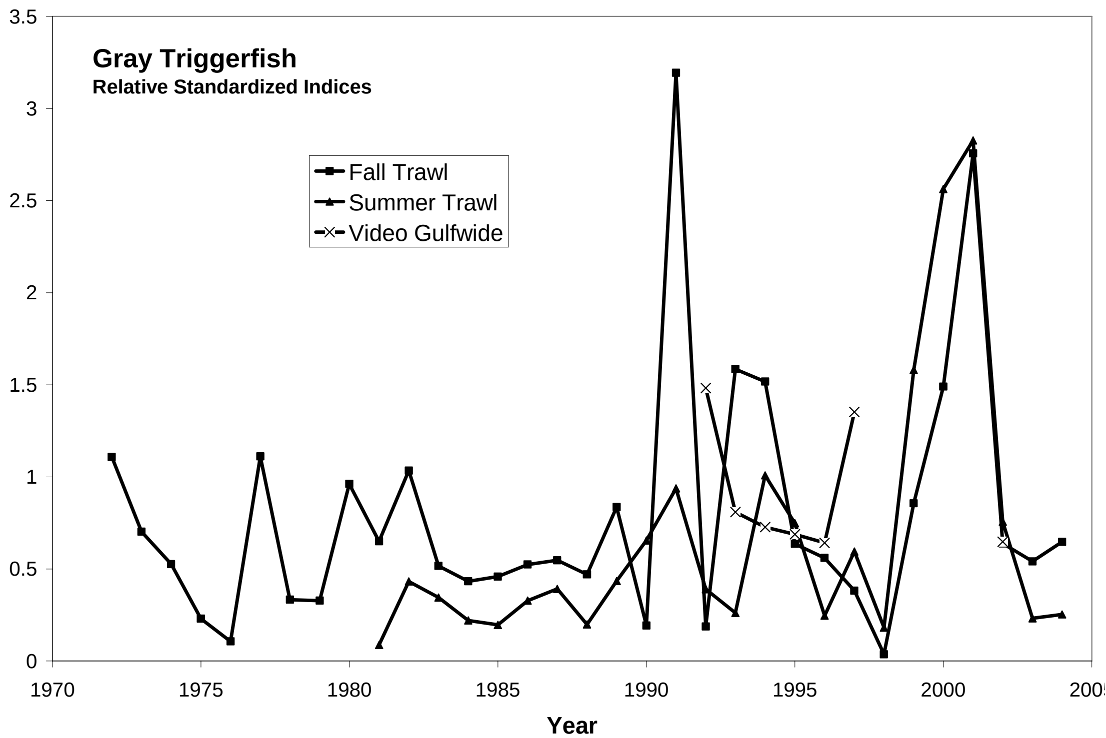

Figure 27—Relative Standardized Fishery Independent Indices

10 Appendix 1.

Recreational landings estimates for TX, 1981-1985.

Prepared June 21, 2005, Patty Phares

I. Available estimates for gray triggerfish, greater amberjack and vermilion snapper in TX

A. TPWD Management Data Series 204 – Private and charterboat only (no headboat).

Annual landings estimates, with a year defined as May 15 - May 14, for 1983/84 through 1997/98.

(Estimates for 1998-99 and later years have not been received yet.)

These annual estimates are what TPWD uses and are based on the same survey data they use to compute the TPWD wave estimates sent to us. If landings by wave are not needed, these annual estimates may be best, at least until the wave estimates for 1983-1997 are replaced (see notes below).

Notes:

(1) The annual estimates were recomputed in the mid-1990s using a revision to the "pressure files", thus eliminating some extreme estimates.

The wave estimates for the 1980s and early 1990s have not yet been recomputed to use the revised pressure files and still contain outliers which may disappear when the wave estimates are recomputed.

(2) The annual estimates are based on 2 fishing seasons (high use and low use) and may be more precise than the sum of the 6 wave estimates.

(3) The annual estimates incorporate data entry corrections not yet made to the wave estimates.

(4) TPWD makes species-specific estimates for selected "target species". The rest of the species are combined in to "other". A "substitute" estimate can be derived for the species in "other" based on the counts of species observed, but these may not be very reliable estimates.

The annual estimates have species-specific estimates for each of these 3 species in gulf areas (not bays) in all years.

Before 1994, the wave estimates have species-specific estimates for vermilion snapper in gulf areas but not for gray triggerfish and vermilion snapper.

B. TPWD Management Data Series 29 and 58 – gulf headboats, through May 1983.

(#29) Annual landings estimates (use gulf headboats):

Sept 1978 - Aug 1979

Sept 1980 -- Aug 1981

Sept 1981 -- Aug 1982

(#58) Landings estimates for a partial year (use gulf headboats):

Sept 1 1982 -- May 14 1983

Notes:

(1) These MDSs were published in 1984 and may not incorporate needed revisions as do those in MDS 204 (no confirmation from TPWD on this yet).

(2) The Sept-Aug years are not comparable to either the May 15-May 14 years or to calendar years.

(3) According to the MDS, not all headboat in the survey areas were found and contacted (apparently a census was attempted) and possibly not all regions were covered (survey areas listed do not include the current "major areas" of gulf waters off Sabine Lake, Matagorda, San Antonio). **The MDS 29 states "Harvest estimates in this study should be considered minimum estimates...".**

C. TPWD wave estimates (estimates made for NMFS) – summed into May-April.

Summed to be comparable to TPWD annual estimates in A (May 1 - April 30, 1983/84 -- 2002/03).

Private and charterboats all years, headboats only in May 1983 - Aug 1984.

D. TPWD wave estimate (estimates made for NMFS) – same as C. but summed into annual Jan-Dec

Summed into annual estimates (Jan-Dec) as would be used in assessments.

Private and charterboats (wave 3-6 only in 1983), headboats only in May 1983 - Aug 1984.

F. MRFSS 1981- 1985. The only estimates are:

1981 waves 2, 3, 5, 6 (waves 1 and 4 are missing). All modes, charterboat and headboat combined.

1982-1984 waves 1-3, 5-6 (wave 4 is missing). Only shore mode.

1985 waves 1-2, 5-6 (wave 4 is missing). All modes, charterboat and headboat combined.

G. NMFS HEADBOAT SURVEY, 1986-1989

Use these estimates to evaluate magnitude and trends in pre-1986 headboat landings in TX.

Before 1997, TX landings were combined for Jan-May and for Sept-Dec.

Area (TTS, EEZ is not known), but all can be assigned to EEZ (area=4) for this purpose. These are gulf headboats (not in the bays).

II. Summary of "holes"

If both MRFSS and TPWD wave estimates are used:

* charter and headboat are combined in MRFSS (are bay headboats included in MRFSS?) .

x = "hole" (no survey or MRFSS estimate lost)

		Shore	Private	Charter	Headboat (gulf)	Headboat (bay)
1981	wave 1	x	x	x	x	x
	wave 2	MR	MR	MR*	MR*	with gulf?
	wave 3	MR	MR	MR*	MR*	with gulf?
	wave 4	x	x	x	x	x
	wave 5	MR	MR	MR*	MR*	with gulf?
	wave 6	MR	MR	MR*	MR*	with gulf?
1982	wave 1	MR	x	x	x	x
	wave 2	MR	x	x	x	x
	wave 3	MR	x	x	x	x
	wave 4	x	x	x	x	x
	wave 5	MR	x	x	x	x
	wave 6	MR	x	x	x	x
1983	wave 1	MR	x	x	x	x
	wave 2	MR	x	x	x	x
	wave 3	MR	TX	TX	TX	TX
	wave 4	X	TX	TX	TX	TX
	wave 5	MR	TX	TX	TX	TX
	wave 6	MR	TX	TX	TX	TX
1984	wave 1	MR	TX	TX	TX	TX
	wave 2	MR	TX	TX	TX	TX
	wave 3	MR	TX	TX	TX	TX
	wave 4	X	TX	TX	TX	TX
	wave 5	MR	TX	TX	x	TX
	wave 6	MR	TX	TX	x	TX
1985	wave 1	MR	TX/MR	TX/MR*	x/MR*	TX/MR*
	wave 2	MR	TX/MR	TX/MR*	x/MR*	TX/MR*
	wave 3	MR	TX/MR	TX/MR*	x/MR*	TX/MR*
	wave 4	x	TX/x	TX/x	x/x	TX/x
	wave 5	MR	TX/MR	TX/MR*	x/MR*	TX/MR*
	wave 6	MR	TX/MR	TX/MR*	x/MR*	TX/MR*

III. DISCUSSION

Comparing data sources in Tables 1 and 2, there is not appearance of comparability among data sources. For instance, in Table 1(a) for gray triggerfish, the TPWD Management Data Series estimates (based on May15-May14 year) and TPWD wave estimates made for NMFS are very different in many years. For MRFSS, there are almost no gray triggerfish estimates, but the leatherjacket family (Table 1(d) bears slight resemblance to the estimates from other sources.

This is true for private and charter (including MRFSS charter + headboat) for all three species (gray triggerfish, greater amberjack, vermilion snapper).

For headboats (without charterboats) compared between TPWD and the NMFS Headboat Survey, the comparisons cannot be made in the same year, but the general magnitude of TPWD estimates before 1985 is not like that of Headboat Survey estimates in 1986+ except for vermilion snapper.

Comparisons are destined to be faulty because of the abundance of "holes" and the different time periods for estimates (not the same 12-month period), different grouping of modes (charterboat and headboat alone vs. separate), and poor quality of some of the estimates. The TPWD wave estimates for these years do not have the benefit of revisions slated to be done, and the sampling levels are especially low for charterboats. The MRFSS estimates before 1986 also are considered less reliable – the charterboat component uses the "old" method for charterboats, and there are weaknesses in the estimates for all modes (early years of survey, less thorough editing of data when all estimates were revised in early 1990s, some procedural or methodological differences?).

In short, it's too messy to try to consolidate the different estimates and fill in the holes. My suggestions are:

(1) Use MDS private and charterboat estimates for 1983-1997 (and use then as though they are calendar year estimates)

(2) Use TPWD wave estimates for 1998+ (these use the calculation procedures that will be applied to the earlier years when time allows for TPWD to do replace the old estimates).

(3) Use the average of the Headboat Survey for 1986-1989 for all years 1981-1985 (perhaps modified by Bob Dixon and TPWD if they believe the fleet was smaller or different).

If this is unsatisfactory, anyone's procedure may be just as good. But there will never be more data, just re-hashing of the same data presented here.